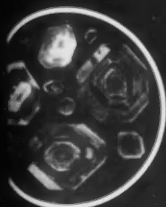
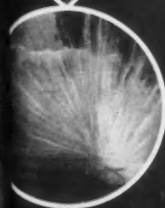


CHEMISTRY



**MARCH
1959**



REINFORCED PLASTICS BRING NEW HOUSING

Homes of Future **APR 7 1959**
May Be Soft Bubbles

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Editorial:

Work and/or Learn in Summer
Inside Front Cover

50¢

A SCIENCE SERVICE PUBLICATION

Work and/or Learn in Summer

► COMPETING WITH conventional vacations at camp or travel at home and abroad, there are many opportunities for secondary school students to learn or work, or do both, during the summer vacation.

Some of the top talented young scientists have in past years had the opportunity to work in some laboratories, notably the National Bureau of Standards, the National Institutes of Health and some industrial or other research establishments, in the year between high school and college or even earlier. A few of the more accelerated students have taken advanced college work.

This summer the work/learn situation is accelerated. The great growth of experimental interest in science fostered by the expanding science club and science fair programs throughout the land has emphasized the ability of young scientists to benefit more widely from this summer training.

Most extensive of the coming summer's programs are the 112 summer science training programs for secondary school students to be conducted in 105 different institutions with funds provided by the National Science Foundation. In these summer courses, between 5000 and 6000 youngsters not yet out of high school will have unequalled chances to learn more than they would with just regular high school work.

These will be matching on a different level the NSF summer institutes for science teachers that do such an effective job in upgrading and improving the capabilities of many of the teachers of the accelerated young students.

In the summer programs training secondary school students, no salaries are paid students but they receive allowances for maintenance, travel and out-of-pocket costs, which makes the summer activity more or less self-liquidating.

Some students find jobs close to home in hospital and research laboratories. There are also a few research assistant type of programs of long standing such as that at the Jackson Memorial Laboratories, Bar Harbor, Maine.

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Plastics With Built-in Muscles

Rising slowly against the tide of unfavorable prejudice, established during the war when they were in infancy, plastics are proving themselves in the construction field. As soon as they are accepted in competition with the more conventional materials, plastics will provide better homes for less money.

► ARCHITECTS, builders and chemists are putting their heads together in increasing numbers to plan startling changes in living and working conditions. Their modern concepts in design and construction are largely being brought about by a tremendous growth in the reinforced plastics industry.

Plastic houses are already a practical possibility and can be on the market soon, pending public acceptance and building code revision. Rigid building codes do not allow for the unusual characteristics of the plastics, so that some compromise must be made.

Since plastics can be molded into various shapes and can be made with continuous and curved lines, many startling possibilities lie open to the architect.

"Why not soft walls," asked Architect George Nelson of New York City. Another designer suggested bubbles, if the cost were right.

Use of these plastics is rapidly growing in the construction field. The biggest single use of reinforced plastics today is for flat and corrugated architectural paneling, both indoors and outdoors. In 1958, from 57 to 62 million square feet of paneling were sold.

The basic comparative advantages of plastic building panels over other constructions were pointed out by Arthur N. Williams, of the Haskelite Manufacturing Corp., at a meeting of the Society of the Plastics Industry.

"The panels," Mr. Williams said, "are non-corrosive, non-rotting, and present no problem of moisture absorption or moisture migration where closed cellular foam plastic core materials are used.

"They have a high strength rate ratio, and from appearance standpoint, structural plastic laminated panels are free from wave and buckle often prevalent in other materials."

Architectural form has been dictated in the past by such building materials as bricks, boards, and beams—which suggest not only rectangular shapes, but rectangular subdivisions as well. The structural plastics permit softer forms, which are more in harmony with nature and which make better use of limited space.

The prime example of this is the Monsanto "Home of the Future" house at Disneyland, Anaheim, California. Using a curve concept, each pound of material goes much farther than in almost any other way. Built almost entirely of plastic, it was found that throughout, in most of the ap-

plications, framing, insulation piping, etc., plastics came off a little better (costwise) than the conventional materials. This has been reported by M. F. Gigliotto of Monsanto.

To date the one who feels most at home in his curved plastic house is an enterprising Eskimo, who has built himself a plastic igloo on Baffin Island

in the Eastern Arctic. Measuring 9 feet high and 18 feet in diameter, the finished igloo can be picked up and carried easily by four men.

But what are reinforced plastics?

The material that has spread itself over such a staggering variety of applications is essentially a combination of polyester resin and fibrous glass.



► **HOME OF THE FUTURE.** *Made of a few large parts rather than many small ones, this plastic house in Anaheim, Calif., takes advantage of the almost unlimited formability and fabricability of plastics. While this may not be the shape of the future, it may be reasonably like it, judging from the favorable response of professionals in the building field and the general public.*

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Liquid polyesters are poured over a fibrous glass form approximating the end-product shape.

Under the influence of chemical catalysts, heat, and pressure, the resin molecules polymerize, or form large complex molecules. The resulting solid mass cannot be softened again by heat or chemicals. The polymerization locks the glass reinforcements into place, providing an inelastic backbone with steel-like strength for the more fragile plastics in which they are imbedded.

Fabricating methods are generally primitive, messy and crude, involve a great deal of piece work and hand labor, and suffer from an acute lack of mechanization. Shops that employ little or no automatic equipment are typical, and those that do operate on a semi-mechanized production basis, are the exception. This lack of mass-production, partly due to the newness of the industry, and to the time lost in handwork, is the reason for the high cost. When these difficulties are overcome, plastic houses will appear in a more favorable light.

Reinforced plastics are not only used in building however.

The first significant applications were in World War II aircraft cells and radomes — the latter being various types of fuselage hoods designed to protect airborne radar equipment without interference with its operation.

Before the war's end, the U. S. Navy Bureau of Ships began experimenting with small personnel boats and similar emergency craft, fabricated from glass-base polyester materials, and pursued the program on a peacetime basis, gradually increasing the

size of the hull and complexity of the design. Today, the sale of reinforced plastic (RP) boats exceeds 60,000 units out of a probable total of 400,000 small craft of all types.

One way or another, reinforced plastics are being applied to the manufacture of some equipment in all the transportation categories, and are becoming increasingly popular as a structural material for cars, trucks, and even small planes; in railroads it is as yet largely limited to passenger equipment.

The fields of aviation and ballistic missiles hold great promise for the plastics, not only because of a high application potential but because of extensive research. In these fields where nothing can be left to chance, more is being done to define the behavior of the plastic under varying climatic conditions than in any other reinforced plastic product group.

With governmental encouragement, some of the large molders are exploring the insulation properties of the synthetic; its reaction to high temperature, etc. The heat properties of the material are a vast improvement over aluminum. At 1000 degrees, for example, the metal may lose as much as 90% of its strength; plastic will drop no more than 20-40%. These characteristics make the reinforced material a "natural" for re-entry nose cones on ballistic missiles, and, in addition to light weight, provide greater durability and shock resistance on all types of aircraft.

Reinforced plastics underwent their most spectacular endurance test to date as a "sound window" for navigational equipment on the bow of the submarine Nautilus that recently

made its heralded trip beneath the polar ice cap. Although details of the application are classified, it can be reported that reinforced plastics offered a unique and necessary combination of qualifications: They are strong enough to stand up under the enormous strain of pushing through icy waters at high speeds, yet they do not inhibit or distort high frequency sonar and radar waves.

The big 55-foot radomes which are now going up on the DEW-Line are all reinforced plastics and are standing up very well. Although they were designed for 150 miles an hour winds, they have stood up to typhoon gusts

in the Pacific areas reported to be over 200 miles per hour.

A reinforced plastic, composed of phenolic resin, reinforced with asbestos, was used for the nose cone of the Vanguard satellite rocket. The choice of material was based on light weight, strength, and high temperature resistance.

A great deal of progress has been made in the improvement of the heat, moisture, and chemical resistance of reinforced plastics. These properties open up vast new areas for use in industrial plants as tank liners, chemical filters, or as nozzles for corrosive liquid spray guns.

Wrapping Offices in Glass

► AN IDEA which "could revolutionize our whole notion of exterior architecture and internal air conditioning and illumination" is being researched at Pennsylvania State University.

The idea is to enclose whole buildings in a glass package. This is called the "air wall construction" by William Hajjar, professor of architecture who also is a practicing architect.

The glass envelope would be spaced from the building's actual facing at any desirable distance.

A blanket of air would be circulated round-and-round or up-and-down the building in the space between the wall and glass.

The idea is that the glass envelope, first, would protect the building, eliminating problems of weatherproofing, and, second, that the circulating air would become a built-in climate controller.

Thus the circulating blanket would

move sun-warmed air to the cool sides of the building, and vice-versa. In winter, heat could be added to this circulating blanket, eliminating duct systems. Mr. Hajjar thinks the idea in practice would help yield comfortable temperature and humidity conditions everywhere in the building.

Furthermore, the scheme offers dramatic possibilities in lighting. At a flick of the switch the air space could be illuminated to provide "daylight" inside at night.

From the angle of architectural design, the air-wall construction is said to offer "every possibility from the virtually inconspicuous to the spectacular." Maintenance would amount to mere washing.

Mr. Hajjar is now probing the engineering aspects with help of architectural engineer Melvin Isenberg, also of Pennsylvania State University. The work is being sponsored by Pittsburgh Plate Glass Company.

Outer Space Radiation Duplicated

► A WORLD of wonders that could change living patterns for all mankind will be explored by General Electric in new facilities for study of nuclear radiation.

Working with nuclear radiations that travel at speeds near that of light itself — that can “see” through concrete and turn wood into edible cellulose — engineers and scientists will help spur the pursuit for practical knowledge and use of the most awe-some forces in creation.

By trying to duplicate radiation in outer space, they will seek — among other things — an answer to how space vehicles and their occupants may be protected from cosmic bombardment.

In many cases, complete equipment, such as motors and transformers, will be radiation-tested while in actual operation. This is in contrast to conventional procedure in which machines and other equipment are generally tested piece by piece.

Nuclear particles that promise new wonders affecting nearly all phases of human life — from helping point the way to reclamation of desert wastelands to ultra-fine measurement beyond the reach of the analytical chemist — will be put to work in three basic operations.

Machinery and other equipment up to about the size of a telephone booth will be studied in a radioactive-cobalt chamber. Inside the sealed “hot room,” 10,000 curies of “Cobalt 60” are contained in a metal basket beneath 16 feet of super-purified water.

It is expected this will be increased to 15,000 curies by mid-year.

By a system of controls located outside the 4½-foot-thick walls of the sealed chamber, the basket is drawn slowly to the top of the well for radiation. Instruments placed both inside the 22-by-12-by-10 foot room and at the remote control panel outside keep a constant check on what is happening at every phase of operation. Visual observation is provided through a water-filled window installed in the thick concrete wall, and by means of closed circuit television.

“There is at present very little information,” Dr. G. W. Dunlap of the laboratory explained, “on how equipment will operate under moderate or low radiation doses over long periods of time.” He said gamma rays emitted by the radioactive cobalt will be trained upon objects for periods of months “or if need be, years.”

So far as is known, Dr. Dunlap said, the cobalt room is the largest yet constructed for this type of investigation. Normally, he pointed out, objects to be studied are placed into a narrow cylinder containing the radioactive substance. “This severely limits the size of the object to be radiated — making it necessary to run the test part by part, and providing no opportunity to observe and instrument the object while under radiation.”

In the new cobalt chamber, entire machines will be radiation-tested under nuclear bombardment up to 500,000 “roentgens” an hour. About .007 roentgens per hour is the most a human being can take. The dose rate

falls off to about 2,000 roentgens an hour in a far corner of the chamber.

Elaborate safety precautions include the 16-foot depth of water shielding the radioactive cobalt when anyone is inside the room. The radioactivity does not remain in the chamber when the cobalt has been withdrawn again into the well.

The new facilities also include two 15-foot-high "accelerators" or "atom smashers" in which electrical particles are given the violent boosts in speed that are required to produce neutron and electron bombardment.

Each accelerator generates one million electron volts — low penetration electrons in one case and high penetration neutrons in the other.

Early investigations with "artificial lightning" — a prelude to some of today's nuclear acceleration work — were pioneered by Charles Proteus Steinmetz, one of the founders of the General Engineering Laboratory.

The combined facilities will permit radiation-testing of a wide variety of equipment and materials — solids, liquids and gases — in a continuation of studies which three years ago led



➤ *RADIOACTIVE COBALT is maneuvered into place at the bottom of a 24-foot well. When raised above the protective shield of water, the cobalt "60" gives off gamma rays that penetrate every corner of the room. Left to right are Fay W. Secor, Vernon W. Perry, and Wallace R. Giard.*

to development of a new-type electrical insulation, first industrial product of nuclear bombardment.

On the Back Cover

➤ *RADIOACTIVE COBALT provides the only light source for this photo taken through 16 feet of water at General Electric's radiation facility in Schenectady, New York. The Company's General Engineering Laboratory will use the cobalt "60" as one means of exploring effects of nuclear energy upon man's technological environment. The "hot" metal is raised into room above protective shield of water when equipment is to be irradiated.*

Elaborate safety precautions include the 16-foot depth of water shielding the radioactive cobalt when anyone is inside the room. The radioactivity does not remain in the chamber when the cobalt has been withdrawn again into the well.

Chemical Reactors

► THE INTENSE radioactive heat found deep in the heart of an atomic reactor may offer a promising way of making chemicals more easily and profitably.

Atomic Energy Commissioner Willard F. Libby told a forum on natural resources conversation in Washington, that a "chemical reactor" has been proposed for production of nitric acid.

The Atomic Energy Commission has been asked to study feasibility of irradiating air in an air-cooled type reactor to make nitrogen oxide, the precursor to nitrogen dioxide and nitric acid.

Dr. Libby said this is such an early development it is "very difficult to assess," but that "the possibilities look bright and encouraging, and there may be other instances of where chemical reactions may be profitably catalyzed by the intense radiation in atomic reactors."

Very Old Phenomenon

At the forum, Dr. Libby also traced the brief history of nuclear energy. It began, he said, with the equation derived by Einstein, that matter in fast motion exhibited an extra inertial mass and that consequently mass and energy might be interconvertible, summed up in $E=mc^2$.

Professor Gilbert Newton Lewis of the University of California was one of the very first people to put this idea to practical application, Dr. Libby went on to explain, by suggesting that the stars derive their energy principally from reactions of the atomic nuclei which convert mass into energy.

The energy of the tides and of all gravitation is not derived from nuclear reactions directly and is in a partial sense non-nuclear in origin. In a very real sense, however, nuclear energy is, in the ultimate, the main source of energy we know, and is thus a very old phenomenon. The sunlight is able to store energy in chemical forms and give us coal and oil and the fossil fuels, but since the sun is a star and derives its energy from nuclear reactions, nuclear energy is the source of the sunlight and thus of fossil fuels.

Reserves of Raw Material

The only nuclear raw materials which promise to be useful in civilian power, he explained, are now, uranium, thorium, deuterium and lithium. The AEC purchases about 30,000 tons of uranium oxide per year and sees no problem in meeting requirements during the next ten years.

Since most of the present reserves have been developed only in the last few years, and much of the world has not yet been explored for uranium, additional reserves will be developed as the market for uranium increases. Eventually, it may be necessary to turn to the low-grade shale and phosphate deposits, which are a tremendous source of uranium. It is possible that we may be short of uranium if we depend upon the burning of natural uranium or uranium-235 derived from it, as our only source of nuclear energy.

Extensive deposits of thorium in India, Brazil and Canada are known to exist although there is only one iso-

tope, thorium-232. Ordinary water contains about one part in 6700 of heavy water or deuterium, so there is no conceivable shortage there. Lithium is very abundant since small amounts are to be found in many igneous rocks.

The lithium-6 isotope which can be converted into tritium for use in fusion reactions constitutes 11% of the ordinary lithium and, therefore, the supply is quite adequate. If fusion reaction is tamed, we would have a vir-

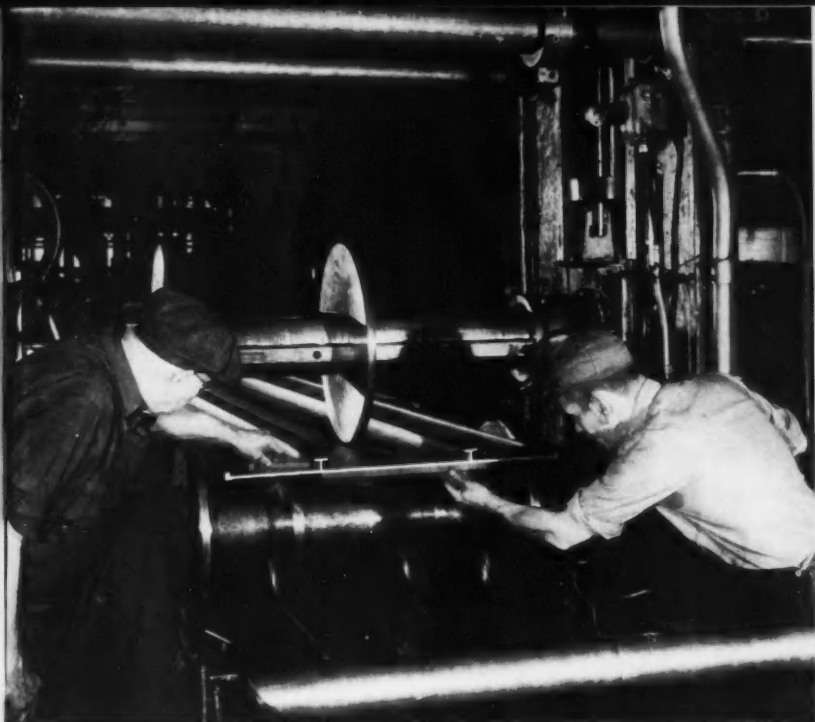
tually inexhaustible supply of raw material in the waters of the earth.

Dr. Libby concluded his speech with a discussion of the Plowshare Project, whose purpose is to put nuclear explosives to non-military applications. This includes moving earth to make harbors and canals, trapping heat to generate steam for power, and using the large quantities of neutrons, which are liberated instantaneously in a nuclear explosion, to make isotopes normally requiring extensive irradiation in chain reacting piles.



➤ "He's right — he does have a photographic mind!"

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► ALUMINUM SKIN for the Air Force Titan, first U. S. intercontinental ballistic missile with an aluminum exterior, is flattened into 34-inch widths for stretch-forming, chemical milling, and welding.

Chemical Milling for Space Travel

► THE INTERCONTINENTAL ballistic missile, Titan, the most powerful missile developed and successfully fired in the United States, is clad in a light, tough, aluminum skin fabricated from metal.

The walls of the propellant tanks in the Titan also form the missile's outer skin, becoming an integral part of the airframe. They are fabricated from large extrusions produced on a

14,000-ton press. The integrally stiffened extruded shapes emerge from the press as 20-ft. long inverted vees. They are flattened into 34-inch widths in Pittsburgh, and then shipped to Denver for stretch-forming, chemical milling, and welding.

Bearing the name given the sun-god by Latin poets, the two-stage missile is designed to blast through the earth's atmosphere on its first stage

rocket power. In frictionless space, the Titan's second stage engine will accelerate the nose cone to astounding speeds. At about 16,000 miles per hour, the velocity required to hurl a warhead 6300 miles, the engine will cut out. The payload contained in the protective heat-resistant nose cone then will coast in a great curving path, reaching a height of some 700

miles before plunging to earth to devastate a target.

The first ICBM with an aluminum exterior, the Titan was designed and built for the Air Force by the Martin Company's Denver division. The aluminum skin was fabricated from metal supplied by Aluminum Company of America.

Glycerine Chemistry

► TWO CHEMISTS have synthesized and examined the unique physical properties of tung oil monoglycerides, which have great potential in sprays as fugitive emulsifiers. In this capacity, the glycerides serve to keep the components in suspension until the material is applied to the surface. On exposure to air, the material loses its emulsifying action, but serves to strengthen the bond between the remaining components and the treated surface.

The scientists received an award for this research work which might lead to improved agricultural sprays. The award was made at the annual meeting of the Glycerine Producers' Association in January to Drs. L. A. Goldblatt and R. S. McKinney of the Southern Utilization Research & Development Division of the U. S. Department of Agriculture at New Orleans, La.

Prior to the work of Drs. Goldblatt and McKinney, no monoglyceride emulsifier with fugitive properties had been developed. Non-ionic in nature, these tung oil monoglycerides avoid disadvantages of ionic materials.

The synthesis and application of these unique chemical compounds has

uncovered a new concept in fugitive emulsifier chemistry and has opened a new and potentially broad field of application for both glycerine and tung oil. Since tung oil is a plentiful farm commodity in the United States, extending its utilization beyond that of a component in oil-based paints is in line with the Government's desire to further increase domestic consumption of farm products.

The Glycerine Producers also honored Dr. Dymtro Buchnea, assistant professor of chemistry at the University of Toronto, for his extensive research on metabolic functions. The natural derivatives of glycerine found in the tissue of living cells, called unsaturated glycerolphosphatides, have been studied and synthesized by Dr. Buchnea, representing a definite advance toward complete understanding of complex biochemical mechanisms.

The director of chemical research for the Tile Council of America, Dr. Herman B. Wagner, was selected to receive the third award for the development of an improved glycerin-containing mortar for setting ceramic tiles, which has simplified the art of tile setting in the United States.

Association Serving Cereal Chemists

► SPECIALIZATION among chemists is as routine and necessary as it is in the medical profession. Thus, professional societies have been founded which service only a few hundred to a few thousand chemists in a single field of interest. The American Association of Cereal Chemists is typical of several hundred highly specialized organizations in existence throughout the United States.

Membership

Members of the A.A.C.C. work primarily in the milling, baking, and feed industries. They are responsible for the development of enriched bread, cake and pie crust mixes, high protein animal feeds, special starches and/or fillers for textiles and paper, and many other edible and nonedible products derived from the cereal grains (wheat, corn, rice, oats, barley and rye). The Association was founded in 1915 and now numbers over 1200 members, the largest single group of cereal chemists in the world. Membership in the A.A.C.C. is maintained by individuals in 26 foreign countries; subscribers to its publications live in 68 foreign countries.

Purposes and Functions

The A.A.C.C. was founded for three major purposes: (1) the encouragement of scientific and technical research on cereal grains and their products; (2) the study of development and standardization of analytical methods used in cereal chemistry; (3) the encouragement of scientific

co-operation among all workers in the field of cereal chemistry.

To carry out these aims, the A.A.C.C. sponsors a national meeting each spring at which some 600 or more cereal chemists gather to hear the latest research findings as reported in 60 to 70 scientific papers. On a regional level, the A.A.C.C. has chartered 17 Local Sections throughout the United States and Canada which offer regular programs for their members, many being held monthly. Opportunity is here afforded for the presentation and discussion of issues of immediate and direct interest to the members attending these sectional meetings. At both sectional and national meetings, members may meet not only others in the cereal field but its leaders as well.

Technical committee work is the backbone of any scientific organization. The A.A.C.C. has at present 16 standing committees working on problems ranging from flour specifications to sanitation. A major committee function is the National Check Sample Service. This group distributes samples of flours and feeds each month to hundreds of collaborators. The results of standard tests made by these collaborators are assembled and analyzed statistically. Two major purposes are served by these co-operative practices: (1) to measure the relative constancy of an analytical or testing technique when applied by numerous analysts to identical material, and (2) to enable the individual operator to note how much his findings depart

from the mean or average of a large group of tests conducted by the same method.

Publications

All scientific research and/or development must be widely reported to serve its full value. The A.A.C.C. has an active publishing program for the benefit of its members and fellow cereal chemists throughout the world. Two periodicals with a combined circulation of over 5500 report everything from pure research to current news and topics of general interest to management. The journals *Cereal Chemistry* and *Cereal Science Today* have international circulations and

reputations. A 528-page manual of standard and approved analytical procedures, *Cereal Laboratory Methods*, has been published since 1922 and is in its sixth revision. A series of monographs or special review books is sponsored by the Association to provide up-to-date and detailed coverage of specialized subject areas in the field of cereal chemistry.

Career guidance and detailed information on the opportunities existing in the cereal field and the activities of the A.A.C.C. can be obtained by writing the national headquarters. Address the American Association of Cereal Chemists, University Farm, St. Paul 1, Minnesota.

Radioactive Sugar Uses Tritium

➤ RADIOACTIVE SUGARS that will greatly facilitate the study of complex chemical processes have been developed by the National Bureau of Standards.

The new sugars contain tritium, the radioactive isotope of hydrogen, as a tracer element. Carbon-14, another tracer element, costs 11,000 times as much as tritium. Tritium gives off no more radiation than can be stopped by a sheet of paper.

The sugars were described to the 40 winners in the 18th annual Science Talent Search. The winners are all high school seniors who were selected from a field of more than 28,000 of the nation's promising scientists to compete for \$34,250 in scholarships and awards.

Tritium-bearing sugars enable scientists to determine the amount of the sugar in any stage of chemical reac-

tion, thereby helping them understand the roles played by individual molecules.

The new sugars may be used, for example, to study how the body converts glucose to galactose and to learn how bacteria react with simple sugars to produce many complex substances.

Dr. Horace S. Isbell, who headed the Bureau's development of the tritium sugars, said that the need for expensive equipment had retarded previous use of tritium for tracer purposes. The Bureau now uses a Geiger-type counter that puts use of tritium for labeling purposes within the means of laboratories all over the country.

Whereas one curie of carbon-14 costs \$22,000, said Dr. Isbell, the same amount of tritium costs only \$2. Also, tritium requires no expensive shielding, as does carbon-14, and lends itself to sensitive measuring.

New Chemical Patents

To obtain copies of these new patents, order them by number from the Commissioner of Patents, Washington 25, D. C. Enclose 25 cents in coin, money order or Patent Office Coupons (but not stamps) for each patent ordered.

Prospectors Consult Bacteria

► BEFORE GAMBLING on expensive rigs and drilling operations, oil prospectors are consulting with natural-born experts, a family of bacteria. These experts have to know where the black gold is; they eat the stuff.

Use of the bacteria is the basis of an invention which earned for James Maddox, Jr., Bellaire, Texas, one of 1,062 patents awarded by the U. S. Patent Office in Washington during a recent week's processing. Mr. Maddox assigned the patent, No. 2,875,135 to The Texas Company, New York City.

The invention takes advantage of the fact that certain bacteria, which consume hydrocarbons contained in petroleum, are found in unusual numbers in the soil over subsurface oil deposits. This is how it works:

Soil samples are mixed with known amounts of a hydrocarbon, then incubated. The mixture is allowed to stand quietly for one to three days. The soil bacteria multiply rapidly with no measurable utilization of the hydrocarbons. Then, with large numbers of bacteria present, the mixture is swished around continuously up to several days, a situation which seems to stimulate the microbes to consume the hydrocarbons.

If there were plenty of oil-eating bacteria in the original soil sample,

the hydrocarbon consumption would be measurable and would indicate to geophysicists that petroleum deposits exist.

Mr. Maddox' exploitation of the primeval oil prospectors is a modification of another system that only recently came into use.

Push-Pull Nuclear Reactor

► A NEW TWIN nuclear reactor has a self-regulating push-pull system for drawing off heat to be used in power production. The invention earned patent No. 2,875,143 for Darol K. Froman, Los Alamos, N. Mex., who assigned it to the U. S. Atomic Energy Commission.

Mr. Froman said the push-pull system has no moving parts and eliminates radioactive gas handling, exhaust equipment, and hazards usually associated with liquid fuel circulation in reactors.

The twin reactors are linked by a heat exchanger. When the first reactor goes critical, released nuclear energy raises the temperature of the liquid fuel, thereby increasing the vapor pressure over the fuel. Forced out of the reactor by the pressure, the liquid passes through the heat exchanger (which draws off the heat for use in power generating facilities) and into the second reactor. The process is repeated and continues to repeat between the two reactors in a push-pull fashion.

Fabric Resists Poison Gases

➤ A PORTABLE KIT enables G. I.'s in the field to impregnate their clothes with a substance that protects them against poison gases.

Consisting primarily of activated charcoal, ammonia and polymeric chemicals, the substance is mixed with water. Clothing is dipped and allowed to dry about 24 hours. Washing with alkaline soap removes the substance.

For the invention, Francis W. Minor, Arlington, Va., and Anthony M. Schwartz, Washington, D. C., received patent No. 2,875,167, which they assigned to the United States of America as represented by the Secretary of the Army.

Nobelists Gets Another Patent

➤ DR. WALTER H. BRATTAIN, Chatham, N. J., one of the three American physicists honored with the Nobel Prize in 1956 for the invention and development of the transistor, has been granted a patent for the invention of a self-powered semiconductor device. Dr. Charles G. B. Garrett, of Morristown, was the co-inventor.

Their device has a sliver of n-type germanium, with an indium-alloyed emitter on one surface. Its other surface is exposed to an electrolyte. Another electrode, with a half-cell potential higher than that of germanium, is also placed in the electrolyte. The device requires no external power supply, since the collector is itself part of an electrolyte cell.

The inventors assigned patent No. 2,870,344 to Bell Telephone Laboratories, Inc., New York City.

Cloverleaf Cyclotron

➤ EDWIN M. McMILLAN, co-recipient of the 1951 Nobel Prize in chemistry,

and David L. Judd, both of Berkeley, Calif., were granted patent No. 2,872,574 for the invention of a cyclotron with a unique magnetic field configuration. They assigned the patent to the Atomic Energy Commission.

Cyclotrons are machines in which electrically charged atomic particles, such as protons and electrons, are accelerated to high speeds by means of an electric voltage. The particles act as bullets by smashing into target atoms whose properties are to be observed and studied.

Prominent among phenomena that tend to limit attainable energy in certain previous cyclotrons, the inventors state, is the increase in mass experienced by particles at extremely high velocities.

Their invention, which they call the cloverleaf cyclotron, embodies a magnetic field configuration that increases in intensity with radius and, therefore, compensates for this relativistic mass effect.

Reactor Shielding Method

➤ EUGENE P. WIGNER, winner of the Atomic Energy Commission's Enrico Fermi Award for 1958, has won a patent for a method of shielding and cooling certain atomic reactors.

Dr. Wigner of Oak Ridge, Tenn., Gale J. Young and Alvin M. Weinberg, also of Oak Ridge, and Leo A. Ohlinger of Chicago were granted patent No. 2,873,243 for their invention.

The method is intended to protect operating personnel of neutronic reactors from neutron, alpha, beta and gamma radiations.

It features a shield comprising a contained quantity of two immiscible liquids of different specific gravity so

that the lighter liquid floats on the heavier liquid.

In a reactor using natural uranium fuel, heavy water moderator and water coolant, the coolant is made to flow through aluminum tubes, containing the uranium, into the unique shield tank. The tubes themselves are immersed in heavy water.

The shield tank is located above the reactor and contains water coolant with a clear low-volatility aromatic hydrocarbon liquid floating on top of it. Thus the coolant is shielded after having passed through the fuel elements.

The inventors assigned their shielding and cooling method to the AEC.

New Way to Package Fluids

► WILLIAM E. MEISSNER of New York City has invented a method of packaging fluids such as milk that will eliminate the need for making the carton leakproof and the risk of having chunks of the container coating contaminate the contents.

By pouring a liquid into a paper carton through a viscous mass of film-forming plastic, a continuous plastic film is formed between the liquid and the carton. When the carton is filled, the film may be sealed about the liquid by pinching it together or twisting it.

Since the main function of the outer receptacle is to provide a sturdy holder for the plastic film and its contents, the carton may be made of any low-cost untreated material. It need not be leakproof.

Selection of the particular material for the plastic film depends on the kind of liquid to be packaged, such as oils or milk.

Mr. Meissner received patent No. 2,872,760 for his packaging method, and patent No. 2,872,766 for an apparatus embodying use of the method. Both patents were assigned to American Viscose Corp., Philadelphia.

Fluorescent Lamp

► A FLUORESCENT LAMP that is easier on the eyes won patent No. 2,864,966 for Laurence Burns, Swampscott, Mass., who assigned rights to Sylvania Electric Products, Inc., Salem, Mass. The lamp uses a tube containing ferrous oxide in the glass to absorb ultraviolet rays generated by the electric discharge inside the lamp. As an alternate, an ordinary tube could be coated with zinc vanadate or some similar material which would convert eye-tiring ultraviolet rays into visible light, he said.

Mr. Burns said emission of ultraviolet light is one of the chief factors causing eye fatigue under fluorescent light. Ultraviolet rays cause the eye itself to fluoresce, thus reducing sharpness of vision. This results in eye strain.

Germ-Killing Soap

► IT IS HARD to find a material to mix into hand soap which will effectively kill skin bacteria during the short time when a person is washing. Sometimes the soap itself interferes with the germicidal action desired.

But Maynard M. Baldwin, Columbus, Ohio, won patent No. 2,864,768 on a chemical which he said is effective in killing skin bacteria. The chemical is a reaction product of a silver salt and ethylenethiourea.

Mr. Baldwin assigned the patent to Permachem Corporation, Palm Beach, Fla.

Atomic-Waste Processing

► TWO ENGLISHMEN won U. S. patent No. 2,864,664 on a chemical method for separating re-usable uranium and plutonium from fission products after atomic fuel has been burned.

According to the patent, which they

assigned to the United States as represented by the Atomic Energy Commission, uranium is extracted first in a process involving nitric acid and nitrate salts, then the plutonium is recovered. The inventors are Robert Spence and Maurice Wolfenden Lister, both of Didcot, England.

Chemical Students in Industry

► ONE OF THE nation's foremost engineering schools and two leading industrial concerns have joined forces in an unusual educational venture to provide professional education for young chemical engineers.

The Massachusetts Institute of Technology, with the cooperation of Esso Standard Oil Company and American Cyanamid Company, now has twenty students assigned to projects at two New Jersey plants. Both graduate and undergraduate students are members of the course.

Half of the students are now at Esso's Bayway Refinery in Linden, and the others are at American Cyanamid's Bound Brook organic chemicals plant. After approximately nine weeks of intensive work, the groups will exchange stations, and continue for another nine weeks to the end of the spring semester.

The two companies are the most recent to have established field stations of M.I.T.'s School of Chemical Engineering Practice. In the Practice School program, students are assigned projects that require initiative in the application of their basic scientific and engineering training.

According to Prof. W. G. Whitman, head of the Department of

Chemical Engineering at M.I.T., the program develops students' abilities to communicate ideas and to integrate human relations problems with their engineering efforts. Prof. Whitman pointed out that the students also must consider economic factors in their Practice School problems and reach conclusions in the light of their economic as well as scientific worth.

What sets the Practice School apart from the usual industrial training program is the presence of a full-time M.I.T. engineering faculty member at the plants. Engineering problems for student investigation are developed jointly by company representatives and the resident professors. The problems are then carefully appraised for educational value before assignments are made. Faculty directors follow the work of each student closely as consultants and advisors.

Problem assignments cover all phases of engineering from research to customer service. Frequently, comments Ross Murrell, manager of Esso's Bayway Refinery, they yield important technical contributions. The companies' use of these results greatly stimulates the confidence of the students in their engineering ability," he added.

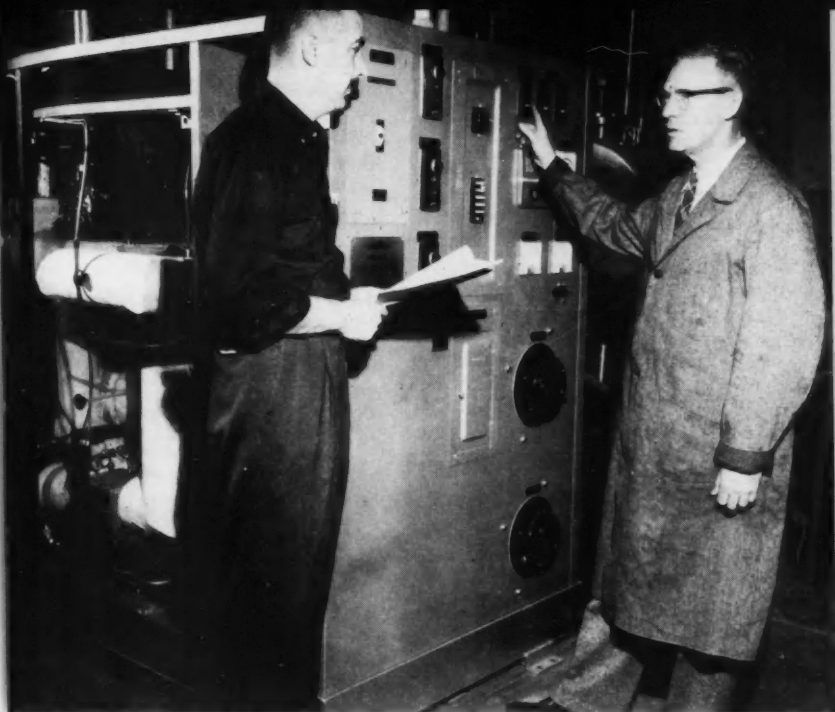
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► *THE FRONT PANEL of the test loop enclosure contains all of the main control devices and instruments in a compact and easily accessible arrangement. Richard C. Andrews of MSA Research Corporation, manufacturer of the apparatus, and Dr. George Austin, chairman of the chemical engineering department at the State College of Washington inspect the equipment during installation.*

Liquid Metal Heat Transfer

► COLLEGES, universities and industrial research centers now can prepare for the study of liquid metal heat transfer without expending valuable time in preliminaries such as designing and assembling the components for a high temperature heat transfer loop.

The answer is a "package" system similar to one recently installed in the

chemical engineering department of the State College of Washington, Pullman, Wash., under an AEC grant to that school, says C. H. Staub, Director, Marketing Division for the MSA Research Corporation, Callery, Pa., designer and manufacturer of the unit. The package is a complete circulation system ready to be put to work as soon as it is placed into posi-

tion. It is adaptable for a great variety of educational experiments and research investigations.

The unit incorporates a heat transfer test loop complete with all necessary auxiliaries such as heaters, coolers, electromagnetic pumps and flowmeters, heat exchangers, plugging indicator, cold trap, and instrumentation. Filled with NaK, an alloy of the metals sodium and potassium having a relatively low melting point, the over-all test loop and its auxiliaries simulate the actual liquid metal heat transfer system for nuclear reactors and chemical processes.

Liquid metals came into prominence as coolants for nuclear reactors because of their good heat transfer properties and stability under high temperature and radiation. Industry uses similar equipment to the heat transfer loop in removing or supplying heat to chemical and other manufacturing processes.

For example, the loop at WSC, designed to operate at 1000 degrees F,

provides almost unlimited opportunities for setting up experimental flow and heat transfer conditions for the study of liquid metal to liquid metal, and liquid metal to air heat transfer.

The equipment will also serve many other useful educational and experimental purposes. It provides for (1) the study of oxygen solubility in NaK, (2) the investigation of the alloy's natural circulation characteristics, (3) the study of pumps and flowmeter performance, and (4) the analysis of the loop in regard to piping arrangement, expansion treatment, and other factors affecting piping layout.

In addition to these instructional purposes, the heat transfer loop is adaptable for comprehensive research projects entailing heat exchanger design, pump development, corrosion and mass transfer studies, valve and thermal insulation development, and metal stress investigation for a variety of applications at medium and elevated temperatures.

Stars and Cosmic Ray Source

► INCREASING evidence that cosmic rays come from the stars and perhaps from distant galaxies was reported by Dr. H. V. Neher, physics professor at California Institute of Technology.

He said possible sources for cosmic rays included supernovae, or exploding stars, and radio signal sources in space. The radiation might also be the residue of the birth or death struggles of stars.

Dr. Neher, a member of the panel on cosmic radiation of the U. S. National Committee for the International

Geophysical Year, has just returned from an IGY expedition that made cosmic ray measurements from sea level to 100,000 feet altitude and from the Arctic to the Antarctic. The information was obtained by radio from 80 instrumented balloons.

It showed that cosmic rays probably do not come from the sun, Dr. Neher found. The IGY study on cosmic ray distribution is supported by the Office of Naval Research and the National Science Foundation.

Balloon measurements give several

hours' worth of data, compared to the few minutes' worth available from rocket flights. Many of the measurements were taken simultaneously from an ocean and a land location.

This double-check method is so the scientists can determine whether variations in the cosmic radiation were due to latitude changes or to world-wide fluctuations.

✓ Chemistry Quiz ✓

Directions: Mark within the parentheses corresponding to the answer you think is *most nearly correct*. Answers are on page 37.

- A. If each of the substances listed in Column I were heated slowly at a pressure of one atmosphere from near absolute zero to 1,000° C, which of the things listed in Column II would happen to each *first*? Place the letter corresponding to the thing (in Column II) in the parentheses next to each substance listed in Column I.

COLUMN I

- () 1. Argon
- () 2. Calcium oxide
- () 3. Carbon dioxide
- () 4. Iodine
- () 5. Limestone

COLUMN II

- a. Boil
- b. Decompose
- c. Melt
- d. Sublime
- e. None of the things listed above

- B. Which of the following is a property of sodium hydroxide?

- () 1. Deliquescence
- () 2. Effervescence
- () 3. Efflorescence
- () 4. Triboluminescence

- C. Several metals are listed in Column I. In Column II are listed important mineral ores of these and other metals. For each metal in Column I, put the letter of its

ore from Column II in the parentheses.

COLUMN I

- () 1. Aluminum
- () 2. Copper
- () 3. Iron
- () 4. Lead
- () 5. Mercury
- () 6. Tin
- () 7. Vanadium

COLUMN II

- a. Argentite
- b. Bauxite
- c. Carnotite
- d. Cassiterite
- e. Chalcopyrite
- f. Cinnabar
- g. Galena
- h. Hematite
- i. Sphalerite
- j. Stibnite

- D. Edible liquid oils are changed into solid fats by

- () 1. a reaction with hydrogen in the presence of a catalyst
- () 2. a reaction with sodium chloride
- () 3. heating to drive off the liquid parts
- () 4. heating under high pressure

Permselective Membranes

by Everett L. Huffman

Associate Chemist, Southern Research Institute

From the Bulletin of Southern Research Institute

► PERMSELECTIVE membranes are plastic films that look very much like the films used to package many of the fruits, vegetables, and meats found in a modern supermarket. However, permselective membranes have one unique property. This property can be explained very briefly. When materials are dissolved in water, they break down into very small charged particles called ions. Some of the ions have a positive charge and some have a negative charge. For instance, ordinary table salt — sodium chloride — when dissolved in water, breaks down into positive sodium ions and negative chloride ions.

The unique property that permselective membranes have is that when they are immersed in a solution, one type of membrane will allow passage of positive ions only, and will block passage of negative ions. The opposite type of permselective membrane will allow passage of negative ions and block passage of positive ions.

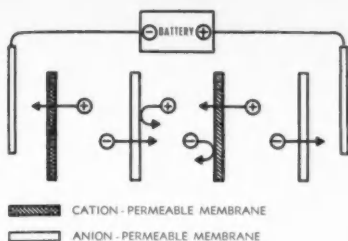
Many industrial applications have been suggested as uses for permselective membranes, since membranes with good chemical, electrical, and physical properties have recently become commercially available.

Permselective membranes seem to be especially suitable for electrochemical processes that produce relatively expensive reactions to be carried out by the application of an electrical force and thus avoids the introduction of

extraneous chemicals which would later have to be removed when the product is purified. Also, the use of permselective membranes can often make possible a chemical process or reaction which would otherwise be impracticable. Despite the large number of potential uses for these membranes, however, the only existing commercial application known to the writer is a process for making fresh water from salty water.

Salt from Brackish Water

The application of permselective membranes that has received most attention at the present time is the removal of salt from brackish water to produce fresh water by a process known as electrodialysis. In this process a large container may be separated into many compartments with permselective membranes, one wall of each compartment being a membrane permeable to positive ions, and the opposite wall being a membrane permeable to negative ions. If a voltage is applied to electrodes placed at each end of the container, the negative ions will move toward one end of the container, and the positive ions toward the other end. Because of the alternate types of permselective membrane walls, the salt is concentrated in alternate compartments, leaving desalted water in the other compartments. The movement of the positive and negative particles is illustrated in Fig. 1.



► FIGURE 1

Waste Recovery

By the same techniques it is possible to recover valuable chemicals, such as chromium and nickel salts, which are now being lost in electroplating wastes.

Purification of Industrial Chemicals

Sugar, glycerine, and many other organic substances are non-ionic—that is, they do not form charged particles when they are dissolved. But in the crude state such organic materials often contain ionic impurities that must be removed. Such purifications may be accomplished by using permselective membranes in a process very similar to the one used in desalting water. Alternate compartments would contain water and a solution of the material to be purified. The ions would then be caused to move from the solution into the water in the adjacent compartments. The water containing the removed ions would be discarded, and a pure solution of the material would be left in alternate compartments.

An analogous process could be used to recover a small amount of a valu-

able ionic material from a large amount of a non-ionic material.

Conversion of Low-Priced Chemicals

According to a recent patent, almost pure sebacic acid, an important component of many plastics, can be obtained by electrolysis of a solution of sodium sebacate in a special cell having a permselective membrane to divide the cell into two compartments. In the chemical process now used to produce sebacic acid from sodium sebacate, the sebacic acid is contaminated with salts that must be removed to obtain the pure acid.

Several years ago Southern Research Institute developed a similar process for recovering sulfuric acid and iron from waste pickle liquor.* In this process the positive ions of iron and hydrogen pass through a membrane into a compartment where metallic iron is deposited on a cathode; negative sulfate ions pass in the opposite direction through another membrane into an anode compartment, where sulfuric acid is regenerated by electrolysis.

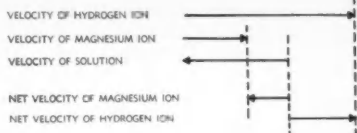
Separation of Similar Materials

When a solution containing ions is subjected to the driving force of an electric field, all positively charged ions move in one direction and all negatively charged ions move in the opposite direction. However, ions with like charges move at different

* Sulfuric acid is used in tremendous quantities to clean, or "pickle," steel. After use, the resulting liquor is a mixture of diluted sulfuric acid and iron sulfate. Waste pickle liquor not only has no economic value—its disposal is a major problem for the steel industry. A good recovery process would therefore have dual benefits: it would minimize the disposal problem, and also reduce pickling costs.

velocities, depending on their atomic make-up. The "ion still" is a mechanism that can be used to separate ions with like charges by taking advantage of this differential in velocity.

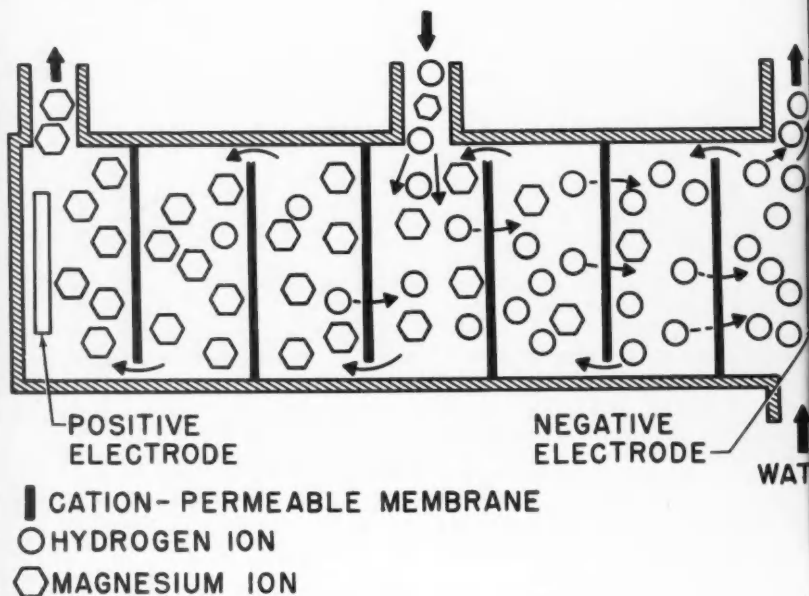
For example, when an electric field is applied to electrodes placed in a solution containing magnesium ions and hydrogen ions, the two types of positive ions do not travel at the same speed, though they do travel in the same direction. The hydrogen ion races ahead like the proverbial hare, while the magnesium ion travels slowly, like the tortoise. The relative velocity of the ions is represented in Figure 2. Now, if the solution is made to flow in a direction opposite to that



➤ FIGURE 2

of the positive ions so that it has a velocity greater than that of the magnesium ion but less than that of the hydrogen ion, the net movement of the two types of positive ions will be in opposite directions. Thus a separation of one kind of positive ion from a mixture of positive ions is possible.

A mechanism used to accomplish



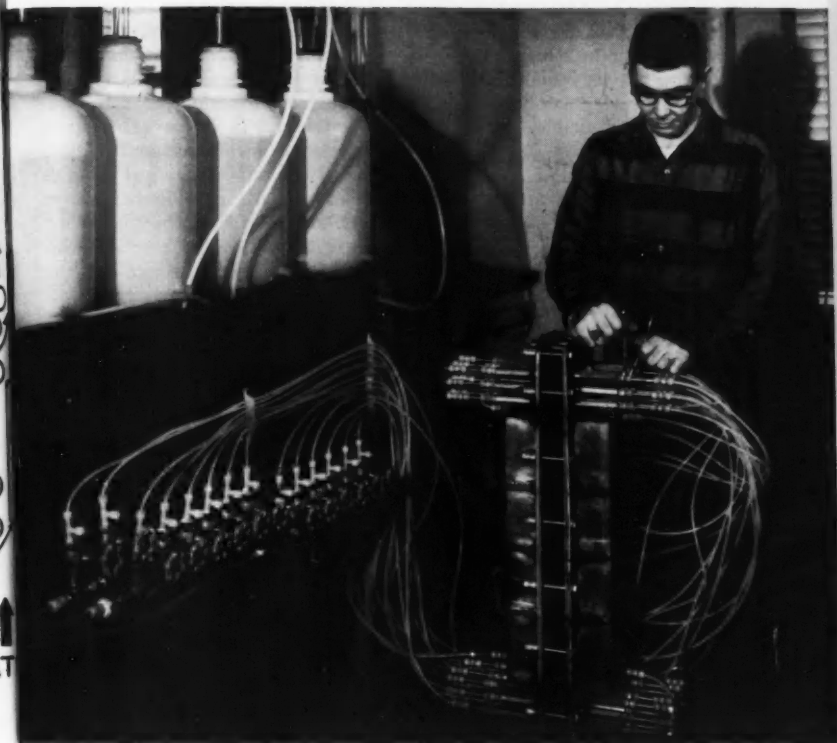
➤ FIGURE 3

this separation, in which permselective membranes are used, is shown in Figure 3. Cation-permeable membranes separate the compartments of this ion still.

The separation could be accomplished without permselective membranes. However, the membranes help to overcome the effect of eddy currents and thermal convection currents

that tend to re-mix the magnesium ions and the hydrogen ions. The membranes are also advantageous because the difference in the speed at which the ions travel is greater in the membranes than it is in the solution.

This method appears, at present, to be best suited for separating materials that cannot be separated by ordinary chemical processes. One example is



► THIS OSMIONIC DEMINERALIZER, which is being developed at Southern Research Institute, uses permselective membranes to convert saline water to fresh water.

atomic isotopes, which have the same chemical properties but different masses. Most chemical methods fail to separate isotopes, but a physical method like the ion still will do the job.

Developments in Technology

So far, this discussion has covered only a few of the applications of permselective membranes which are known to be technically feasible. Many other applications may be suggested which are logical extensions of the present state of membrane technology, but which have not yet been shown to be technically feasible, mainly because of a lack of experimental work.

The lower cost of permselective membranes when they are produced in larger quantities should make many processes economically attractive which are not now practical because of the high price of membranes. For example, in the demineralization of brackish water to produce fresh water by permselective membrane processes, almost half of the total cost of the fresh water is due to the cost of the membranes. A reduction in the price of membranes would result in

an important decrease in the cost of producing fresh water.

Considerable work is being done on improving the various properties of permselective membranes. In the future it is likely that permselective membranes that are selective, not only to ions of one charge, but to ions of one chemical species, will be developed. These highly selective membranes will allow passage of ions of only one element or of a very small group of elements rather than passage of all ions of like charge as do present permselective membranes. For example, the ions of sodium, calcium, nickel, and iron will all pass through a permselective membrane which allows passage of positively charged particles or positive ions. The highly selective membranes of the future may allow passage of only one positive ion, such as nickel, and block passage of other positive ions and all negative ions. Similar permselective membranes which are highly selective for negative ions are also expected to be available. It seems safe to predict that advancing technology will bring permselective membranes into much wider industrial use in the near future.

Atomic Samples for Scientific Store

► ATOMIC ITEMS, including uranium, tritium and carbon-14, have now been added to the Government's store of scientific samples.

The store, known formally as the Standard Samples Storeroom of the National Bureau of Standards, U. S. Department of Commerce, sells only samples of materials whose composition, purity or properties have been evaluated and certified.

These materials may be metals, ores, chemicals, rubber, glass, ceramics, rocks, or even paint or sugar. The 600 kinds of samples now in stock enable industry to keep its instruments in order, maintain the quality of its output, and settle arguments with customers.

A series of standards containing known amounts of uranium-235 as well as other isotopes of uranium have

been developed for use in testing nuclear fuels and other atomic energy research. These materials are available only to buyers licensed by the Atomic Energy Commission.

Eight samples are now on sale and another seven will be added within a few months.

Many of the items on the shelves look like a druggist's wares, neatly labeled cardboard cylinders containing sealed bottles. One bottle may contain shot-sized chips of Bessemer steel whose analysis has been certified by the National Bureau of Standards and a half dozen outside laboratories. An-

other may hold opal glass in the form of a fine white powder whose composition also has been determined by Government, university and industrial chemists.

Some samples, too dangerous to keep on the shelf, are stored in radiation-proof vaults. Among these radioactive materials are tritium (hydrogen-3), with which the ages of wine and liquor may be determined, and carbon-14, the isotope with which scientists date ancient archaeological specimens that once were living things.

First Nuclear Rocket Motor

► WHEN THE first operational nuclear rocket motors are built, we should not expect them to be "spectacularly better" in performance than chemical systems.

But the energy will be there, and ways will be found to convert it more efficiently to jet thrust.

This view was expressed by Dr. Theodore P. Cotter of the Los Alamos Scientific Laboratory to the Institute of the Aeronautical Sciences during a Symposium on Aero/Space Technology.

Chemical propulsion systems, said Dr. Cotter, are rapidly approaching the upper limit of their available energy spectrum, while nuclear systems use only a small fraction of their available energy.

It is still not known, he said, how a successful nuclear rocket motor comes into being, but much has been learned about the problems and future procedures. Early work has convinced scientists that such develop-

ment will be expensive and demanding of talent and hard work.

The real problem of nuclear rocket propulsion is "to demonstrate performance which is in some recognizable sense better than a competitive chemical rocket system."

He said the large gap that lies between the energy available in nuclear reactions and the use that can be made of this energy for rocket propulsion, together with the wealth of possibilities for closing that gap, provide ample stimulation to the search for better systems.

Dr. Cotter said there are two generally recognized areas of potential nuclear rocket superiority. First, delivery of large payloads from the ground, or near it, to ranges requiring high velocities. Second, space flights with substantial payloads using small accelerations over comparatively long periods of time. The propulsion systems in the two areas, he said, are quite different.

Ozone and Sodium Hypochlorite

by BURTON J. KROHN, Hillsboro H. S., Nashville, Tenn.

Given Honors in the 18th Science Talent Search

► MY PROJECT actually began with the building of a crude ozone generator as a chemistry project, a year ago. The uniqueness of the chemical activity of this gas caused my interest in this subject to develop, and I decided to extend my work and research deeper, after further encouragement by an extra chemistry course last summer. The purpose of this project, as well as studying the effect of ozone on a hypochlorite bleach solution and quantitatively analyzing a solution of possibly four similar components, plus a gas, is to develop accurate and efficient scientific laboratory techniques.

The Ozone Generator

My ozone generator, simple though effective, consists of a 6 mm pyrex glass tube bent into a right angle about 8" from one end and drawn into a jet about 10" in length at the other. The inner electrode is a 6" rat-tail file, and the outer electrode is aluminum foil wrapping. A 12,000 volt current produces a brush discharge around the glass. The flow of oxygen through the system is regulated by a homemade siphon mechanism and an adjustable pinchcock, since an oxygen tank regulator costs over \$30.00. The jet serves to enlarge contact surface area between gas and liquid as the oxygen-ozone mixture is bubbled through test solutions.

With moderate but growing suc-

cess, I have kept the oxygen flow-rate at 100 ml per minute. Also to increase efficiency, water vapor, which catalyzes decomposition of ozone, is at least partially removed with calcium chloride. Despite precautions, the efficiency has constantly been hampered by leaks, which only recently I have succeeded in minimizing. The concentration of the ozone produced is approximately 1%.

Plan of Action

At the beginning of my project the question in my mind was whether ozone is sufficiently powerful to oxidize the chloride ion from the -1 oxidation state to $+1$ in hypochlorite, $+3$ in chlorite, or $+5$ in chlorate. This question was answered by H. Willard and L. Merritt, Jr., in the 1942 Analytical Edition of *Industrial and Engineering Chemistry*: the change effected by ozone upon the chloride ion is negligible. I then turned to the possibility of raising hypochlorite from $+1$ to a higher oxidation state. I found no information about such a reaction; therefore I chose this question as a project.

In the reaction between ozone and a hypochlorite there is a possibility of five resultant products; unreacted ClO^- , Cl^- , ClO_2^- , ClO_3^- , and the gas ClO_2 . The problem is the quantitative determination of each component and the establishment of proportions

in which they occur. After considerable research into chemical properties of these compounds and possibilities (including ion exchange resins) for their separation and analysis, I decided upon the following steps (see equations):

Before Ozonation

1. Iodometric determination of total active oxygen content.

2. Argentometric determination of total chlorine content. ClO^- is reduced to Cl^- with hydrogen peroxide. This step accounts for any Cl^- formed by natural decomposition of ClO^- .

After Ozonation

1. Iodometric determination, in moles, of increase or decrease in total active oxygen content. This test will not include ClO_3^- , if it is formed.

2. Argentometric determination of total chlorine content. ClO_2^- and ClO^- are reduced as in step 2 before ozonation. If total Cl is less than before ozonation, it may be due to one of two factors, or both. One possibility is the formation of ClO_3^- , which, as I proved by experiment, is not reduced appreciably by H_2O_2 , even when the mixture is boiled. If ClO_3^- is formed, it can be quantitatively reduced to Cl^- by boiling with sodium nitrite. The other possibility is the loss of chlorine as ClO_2 gas, whose quantity can be calculated by subtracting the total Cl content after all reductions, from the total Cl content before ozonation.

3. Separation of ClO^- and ClO_2^- . The mixture is titrated against a slightly basic solution of arsenite, with which only ClO^- reacts, and quantitatively. Methyl orange solution is used as indicator.

4. Estimation of Cl^- formed during

ozonation. If the total chlorine found in step 2 after ozonation is greater than the sum of the chlorine in all ClO^- , ClO_2^- , and ClO_3^- determined after ozonation, then this difference resulted from one of two causes or both. One possibility is the chloride ion formed during ozonation; the other is the remaining original chloride present before ozonation, due to previous decomposition of ClO^- . The chloride formed during ozonation may be calculated by subtracting this remaining chloride, which is the difference in moles between steps 2 and 1 before ozonation, plus the combined number of moles of ClO^- , ClO_2^- , and ClO_3^- , from the total chlorine found in step 3.

Results

As of now I am well into step 1 after ozonation, and I have also begun work on more difficult step 2. In each test in the first step 2000 cc of O_2/O_3 mixture is bubbled through 30 ml bleach solution diluted to one hundredth of its original strength. Fifty ml of 0.02 M potassium iodide solution, plus 1 ml of 99% acetic acid is used in the titration flask, and a standard 0.005 M solution of sodium thiosulfate is titrated against the liberated iodine. My starch indicator suspension (as recommended in "Iodometric Determination of Inorganic Substances, Volumetric Analysis, III") was prepared by making a paste of 2g corn starch plus 1 mg mercuric iodide as a preservative in 30 ml distilled water, and adding this to sufficient boiling water to make 1 liter. I found this preparation to be very satisfactory in providing precise, clear end-points.

Recorded are results of 27 tests (see table), which vary so widely, that

their average cannot be considered near conclusive. However, without exception, in each test the total active oxygen after ozonation is less than in the tests taken each day before ozonation, but the average number of moles lost is equal to only 3.2-4.7% of the amount of ozone used. Perhaps after tabulation of about 60 tests a more accurate figure may be obtained.

In my work in step 2, I add 2-3 ml of full-strength hydrogen peroxide to 30 ml test solutions and boil for 5 minutes. The Cl^- formed is titrated against 0.01M silver nitrate, using precipitation of red silver chromate as indicator. The major difficulty is distinguishing the end-point, which is not as clear as the starch indicator in iodometry. Ten inconsistent tests have shown my need for more practice in this titration.

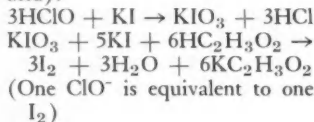
Steps 3 and 4 remain in the future until my other data show conclusive results, and my familiarity with, and habits in, the chemical laboratory further improve.

I believe that this project in its planning, experimenting, and calculating has thus far helped to develop, through failure and success, my persistence and attitude as a scientist.

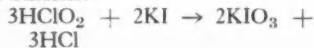
Important Equations

1. Iodometric determination of active oxygen.

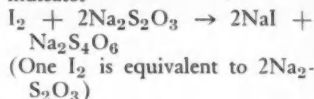
a. Hypochlorite (iodide solution is acid):



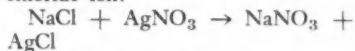
b. Chlorite:



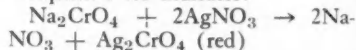
(One ClO_2 is equivalent to 2I_2)
c. Iodine and thiosulfate — starch indicator



2. Argentometric determination of chloride ion:

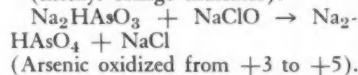


Equation for indicator:

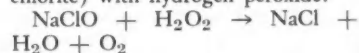


3. Arsenite method for separating ClO^- and ClO_2^-

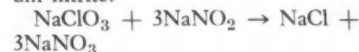
(methyl orange indicator):



4. Reduction of hypochlorite (or chlorite) with hydrogen peroxide:



5. Reduction of chlorate with sodium nitrite:



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(a) "Arsenic", Volume I (1946), pp. 326-342.

(b) "Chlorine", Volume II (1948), pp. 701-719, 725-731.

(c) "Oxygen", Volume V (1953), pp. 295-300.

2. Samuelson, *Ion Exchangers in Analytical Chemistry*, Chapter II, "Fundamental Properties of Ion Exchangers," Chapter V, "Ion Exchange in Column Operation," Chapter VI, "Technique of Ion Exchange Separations for Analytical Purposes," 1956.

DATA AND RESULTS OF 27 IODOMETRIC TITRATIONS OF HYPOCHLORITE AFTER OZONATION

Before Ozonation

After Ozonation

No.	Date	Concen. CIO (M)	Moles CIO	No.	Concen. CIO (M)	Moles CIO	Moles of Active O Lost
1.	11/17	0.0163	0.000489	1.	0.0158	0.000474	0.000015
2.	11/17	0.0163	0.000489	2.	0.0158	0.000474	0.000015
3.	11/19	0.0161	0.000483	3.	0.0154	0.000462	0.000021
4.	11/19	0.0161	0.000483	4.	0.0154	0.000462	0.000021
5.	11/30	0.0165	0.000495	5.	0.0157	0.000471	0.000012
6.	11/30	0.0165	0.000495	6.	0.0147	0.000441	0.000042
7.	11/30	0.0165	0.000495	7.	0.0156	0.000468	0.000027
8.	11/30	0.0165	0.000495	8.	0.0156	0.000468	0.000027
9.	11/30	0.0165	0.000495	9.	0.0151	0.000453	0.000042
10.	11/30	0.0165	0.000495	10.	0.0141	0.000423	0.000072
11.	12/12	0.0155	0.000465	11.	0.0143	0.000429	0.000036
12.	12/12	0.0155	0.000465	12.	0.0132	0.000396	0.000069
13.	12/13	0.0155	0.000465	13.	0.0139	0.000417	0.000048
14.	12/13	0.0155	0.000465	14.	0.0139	0.000417	0.000048
15.	12/13	0.0155	0.000465	15.	0.0152	0.000456	0.000009
16.	12/13	0.0155	0.000465	16.	0.0147	0.000441	0.000024
17.	12/13	0.0147	0.000441	17.	0.0141	0.000423	0.000018
18.	12/13	0.0155	0.000465	18.	0.0142	0.000426	0.000039
19.	12/13	0.0155	0.000465	19.	0.0146	0.000438	0.000027
20.	12/13	0.0155	0.000465	20.	0.0139	0.000417	0.000048
21.	12/13	0.0155	0.000465	21.	0.0150	0.000450	0.000015
22.	12/15	0.0152	0.000456	22.	0.0147	0.000441	0.000015
23.	12/15	0.0153	0.000459	23.	0.0143	0.000429	0.000030
24.	12/15	0.0153	0.000459	24.	0.0137	0.000411	0.000048
25.	12/15	0.0153	0.000459	25.	0.0141	0.000423	0.000036
26.	12/18	0.0151	0.000453	26.	0.0145	0.000435	0.000018
27.	12/19	0.0149	0.000447	27.	0.0139	0.000417	0.000030

Average number of moles lost:
0.000032

Moles of ozone used: 0.00068 to
0.00100

Part of ozone which reacted with
hypochlorite: 3.2 - 4.7%

Considering barometric pressure,
added water pressure from the siphon,

and vapor pressure of water, all data
in the last three columns are converted
to the equivalent of 2000 cc oxygen-ozone
mixture at 30.6" mercury
and a temperature of 19.1°C.

In all tests 30.0 ml of solution was
used, except 17 and 22, which were
28.4 ml and 29.7 ml, respectively.

America's first and fastest prop-jet airliner utilizes a plastic adhesive
for bonding metal to metal that is stronger than the metal itself.

Hydrogen--Oxygen Fuel Cell

by LEAF TURNER, *Stuyvesant H. S., Brooklyn, N. Y.*

Given Honors in the 18th Science Talent Search

➤ RECENTLY, a device that has been known since the beginning of the century has finally received its deserved recognition. This is the fuel cell. The significance of the fuel cell is that electricity is generated directly from fuel by an electrochemical reaction.

Because of the importance that might result from further research concerning this cell, I decided last June to collect as much data about it as I could. Unfortunately, there was relatively little information. In the *July General Electric Review*, I came across an article on the fuel cell. I wrote to the authors, Dr. Liebhafsky and Dr. Douglas, requesting further information. They generously forwarded me enough for me to begin my work. In July, also, in the *Journal of the Electrochemical Society*, I found "The Fuel Cell Round Table" which contained a summary of all the work that had been done on the fuel cell.

There were three kinds of fuel cells suitable for my project: a redox cell, a hydrogen-oxygen fuel cell, and a high temperature carbon monoxide-oxygen or hydrogen-oxygen cell. I decided that the hydrogen-oxygen cell was best suited for construction and laboratory experimentation.

Construction of Cell

The two porous graphite electrodes that I am using were obtained from two dry cells. I feared that the not too delicate strokes of the hammer necessary to break open the dry cells might

cause the electrodes to break and that much time would therefore be lost. Fortunately, this was not the case.

At this point, my problem was to devise an efficient method of having oxygen adsorbed onto the surface of one electrode and hydrogen adsorbed onto the surface of the other. I cut off from the electrodes the ends having the metal binding posts. I obtained the use of a lathe with which I drilled a hole four inches into the electrodes from one of the ends. These holes had a diameter $\frac{1}{8}$ inch greater than the diameter of the glass tubing, $\frac{3}{16}$ inch, that I later inserted into these holes for the gas inlets. Half of my problem was solved, since the gas now would pass very close to the surface of the electrodes.

The other half of my problem was to obtain proper catalysts to adsorb these gases. With the help that General Electric offered me, I was able to choose my catalysts: for the hydrogen electrode, I decided to use platinum from thermally decomposed platinum chloride; for the oxygen electrode, I adopted the recommendation of Kordesch and Marko, which was a solution of 2.4 g. $\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ plus 6.2 g. $\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$ in 100 cc. of water.

In order to coat the surface of the hydrogen electrode, I poured a solution of platinum chloride into the center of the electrode. I heated the electrode until the water evaporated and the surface was coated with platinum chloride. Then I carefully heated the

entire electrode until I saw a metallic coat on the electrode which I knew was thermally decomposed platinum.

In the other electrode, I evaporated 80 cc. of the nitrate solution and heated the entire electrode at 800 degrees Centigrade to convert the nitrates to oxides. I have had to take great care in the heating of these electrodes for fear that they might crack.

My next step was to find some type of cap to cover the openings of the holes, through which I could pass two tubes, one an inlet for the gas and the other an outlet. I decided to drill a $\frac{3}{4}$ inch hole into two one-holed rubber stoppers in order to cap the electrodes. This hole is smaller than the diameter of the electrodes, so that the stoppers might fit air-tight over the electrodes. Then, through the side of the stoppers, I drilled a $\frac{3}{16}$ inch hole to fit the outlets. After I put the stoppers over the electrodes and inserted into the holes the glass tubing for the inlets and outlets, I connected the inlets with an air supply. I found that a great amount of air was leaking from the area between the stoppers and the electrodes. In order to correct the leak, I used rubber cement. I found this unsatisfactory because the air, which was under considerable pressure, bubbled through the cement. Next I tried Duco cement. This seems to be serving my purpose well up to the present. I anticipate, however, that even this cement will not be completely satisfactory because it is inflammable. If necessary, I may try Miracle adhesive; but, here again, I may have the same problem.

At this point, I had to obtain a three-neck flask, in which I could put my electrolyte (KOH solution) and

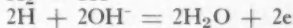
into which I could insert the two electrodes and a Liebig condenser, which would condense any water that might evaporate from the electrolyte. I could not fit the electrodes into the necks of the flask I obtained, because the diameter of the necks was slightly too small. I decided to sand down the electrodes.

In the next phase of the experiment, I am going to fit the two electrodes into the two necks of the flask and a Liebig condenser into the third. My electrolyte will be a solution of 30% potassium hydroxide in water. Then I shall have to obtain my hydrogen supply.

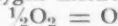
Theory of Fuel Cell

The principle of this device is as follows. Oxygen molecules are adsorbed on the surface of the positive electrode. This adsorbed layer, being more active than molecular oxygen and being free, combines with the water in the electrolyte to form two hydroxyl ions. Each of these ions, having a single negative charge, removes an electron from the oxygen electrode, making the electrode positive. These hydroxyl ions migrate to the other electrode and combine with the adsorbed hydrogen to form water, depositing electrons in the process. Since the hydrogen electrode is negatively charged and the oxygen electrode is positively charged, electrons may flow through the external circuit. The following equations summarize the foregoing.

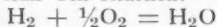
Hydrogen Electrode (Negative Pole):



Oxygen Electrode (Positive Pole):



Overall Cell Reaction:



After I have my fuel cell working, I shall plot its various characteristics, e.g. current density versus voltage at different temperatures. Basing my information on what I have read on the low temperature hydrogen-oxygen fuel cell, I should obtain approximately .73 volts and a current density of 1 mA/cm².

Advantages of the Fuel Cell

As the world population increases, demand for electricity will increase. Fuel resources are constantly diminishing and the cost is rising. A more efficient and economical method of producing electricity must be devised.

The present method of producing electricity involves the use of steam

engines. The efficiencies that have been obtained are about 30%. Thermodynamic laws set an upper limit on the efficiency.

The fuel cell, however, converts all chemical energy directly into electricity without the loss of energy incident to the use of steam engines.

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- 3.) Fifth World Power Conference — Recent Research in Great Britain on Fuel Cells.
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Sun-Power for Space Vehicles

► BY USING the heat of the sun to generate thermoelectricity, a simple, reliable and lightweight power source may be developed for space vehicles, according to Dr. J. C. R. Kelly, Jr., manager of the technology department of the Westinghouse Research Laboratories, Pittsburgh, Pa.

To illustrate progress already made in thermoelectricity, Dr. Kelly presented a demonstration that was "all done with mirrors" for the special benefit of the 40 winners of the 18th Science Talent Search and members of Congress from the winners' home districts.

In the demonstration the light and heat of an electric arc, substituting for that of the sun, was beamed from a curved mirror to a second mirror some distance away. The second mirror concentrated the heat rays and focused them on a small thermoelec-

tric generator which directly converted the heat energy into sufficient electric power to run a small motor.

Dr. Kelly's presentation of the challenging new field, which will need the cooperative research of physicists, chemists and engineers, was the high point of the dinner meeting in Washington.

Dr. Kelly showed additional examples of developments in thermoelectricity by demonstrating such solid state devices as a copper teakettle, with a base containing thermoelectric materials, that converted the heat of a gas flame into enough power to run a small motor and radio; a thin panel that gave off light, heat and cold; and a thermoelectric generator that ran a 110-volt motor, a fluorescent lamp, a 300-volt electroluminescent panel, a 50,000-volt spark gap and a full scale public address system.

The Rare Earths

► SINCE ATOMIC FISSION, developments in the rare-earth industry have occurred with increasing rapidity. Within the last ten years, the last of the new elements has been isolated, separation methods have been developed, and new deposits — some of a new mineral — have been placed in production. Consequently, there has been an ever-intensified search for new uses for the elements and their compounds, in an effort to increase their market.

Fifteen rare earth metals receiving particular attention today are the elements numbered 57 through 71, starting with lanthanum and ending with lutecium, usually called the Lanthanoid Series. Yttrium, number 39 on the periodic table, is often included in this group, because it is found in close association with the rare-earth elements and is difficult to separate from its companion metals. The newest, and the only one not found in nature, is promethium, named for the Greek god of fire because it is created only in the furnace of nuclear disintegration, a fission product of uranium-235.

History

Early chemists used the term "earths" to denote oxides that were insoluble in water and infusible. Hence, in 1794, when an extracted oxide was identified as new, the term "rare earth" was applied to distinguish it from the better-known lime, magnesia, and alumina.

The new oxide was later found to be divisible into groups and then into individual oxides. In the succeeding years, the term was applied to elements. Today they are far from rare

and are available in quantity and at declining prices. They are helping to trap neutrons in nuclear reactors, light cigarettes, protect glass-blowers' eyes, send long-distance radio messages, and relieve sea sickness.

Misch Metal

The rare earths are often used as a mixture, called misch metal. Because they are hard to separate, their individual characteristics have not been well known. The normal composition is approximately 45 to 50% Ce, 18% Nd, 5% Pr, 1% Sm, and 22-25% La, and small amounts of other rare earth metals. Magnesium is sometimes intentionally added as a stabilizer to retard atmospheric corrosion.

Yttrium

Yttrium, a metal long considered too brittle for structural uses, has recently been transformed into a pliable, easily formed material that may find important applications in atomic reactor and missile designs.

The transformation method was discovered by U. S. Bureau of Mines metallurgists in Albany, Oregon, who learned recently that yttrium's forming qualities could be improved by ridding it of dissolved gases.

Yttrium's advantage in the nuclear field is its relatively low thermonuclear cross section. This means it has less resistance than many other materials to the passage of neutrons needed to sustain a nuclear reaction.

The metal also has a melting point of 2,825 degrees Fahrenheit, about equivalent to that of carbon steel, and

high enough to enable it to withstand reactor temperatures.

The best yttrium available before the discovery of the new method had limited ductility, even though it was almost free of contaminants. Although the method does not reduce production costs, it does not increase them significantly and certainly results in a material with improved ductility capable of wider applications.

The Bureau of Mines foresees a potential value for yttrium in alloys. Moreover, availability of the metal in ductile form will permit a re-evaluation of its possible applications in other important fields.

Use of the Rare Earths

Nearly all of the important uses for rare earths are based on properties of the rare earth elements. For this reason, the uses below are given by use rather than by specific rare earth material.

About one-quarter of the rare earth chemicals produced are used in carbon arc lighting applications. Rare earth-cored carbons are indispensable to the motion picture industry, both in studio lighting and in theater projection. Army, Navy, and Coast Guard searchlights also use these rare earth-cored carbons.

Another quarter of the production is used in the form of mixed rare earth metal and cerium metal. These are used in lighter flints, magnesium

alloys, and in some of the ferrous alloys. In rare earth alloy production, some applications use rare earth salts instead of metals.

The third quarter of rare earth production is used in the glass industry. Didymium and cerium salts, and some separated rare earths, have important uses both in the coloring and the decolorizing of glass.

Cerium oxide and some forms of specially prepared rare earth oxides are widely used in the polishing of spectacle and optical instrument lenses and in the surface preparation of mirror glass and other glass specialties. These polishing agents are essential to the defense effort because they are vital for the polishing of precision optical parts for bomb sights, range finders, periscopes and fire control instruments.

Future

Dr. William F. Meggers, one of the scientists doing basic research on rare earth metals at the National Bureau of Standards, U. S. Department of Commerce, calls their potential uses limitless. Within a few years, he expects them to be as well known as iron and nickel. At the Bureau they are being studied by several methods, including spectroscopy (analysis by wave-lengths spread out with a prism), purification with ion-exchange resins, a method analogous to distillation, and X-ray analysis.

Plastics in Gardening

► THE USE OF black plastic as a mulch can reduce gardening work. The plastic is black in order to exclude light, and while it is true that occasionally a spear of grass may pierce the plastic

material, most weeds under it will germinate and then die because of lack of light.

If the gardener objects to the appearance of the black plastic in the

garden, he spreads a thin layer of soil over its surface.

The plastic is usually put down prior to planting either seeds or transplants, and then these are planted in holes cut in the plastic. To hold it in place a shallow furrow is made along the edge of the plastic, and the edge of the material is placed into the furrow.

The furrow is then filled with soil to hold the plastic in place. At the

end of the season it can be taken up and stored for use the following season.

In addition to controlling weed growth and thereby eliminating the necessity for hoeing or cultivation, the plastic mulch also reduces the evaporation of water from the soil surface and thereby conserves soil moisture. Water from rains or irrigation reaches the soil through the holes through which the plants grow.

Tailored Molecules

► "MOLECULAR engineering," which means custom tailoring chemicals to fit specific needs, is a "truly revolutionary" development that will allow our expanding population to continue its explosive growth.

This view was expressed by Frederick T. Moore, economist with the Rand Corporation, at a symposium on the outlook for chemical technology sponsored by Resources for the Future, Inc. Mr. Moore said that the recent products of the chemical industry showed the idea of an exploding population that depends on a fixed resource base is "essentially a myth in the long run."

Economic growth, he charged, will not be limited by a shortage of natural resources. Products of chemistry are better and cheaper substitutes for products that come from more scarce natural resources such as metallic deposits.

Another result of molecular engineering, Mr. Moore predicted, will be a speed-up in the progress of underdeveloped countries, since the U. S. can export chemical techniques for obtaining useful products from low

value resources. This is preferable to these countries trying to duplicate exactly existing U. S. industries, which have been shaped by this country's economic history and resources available.

Concerning chemical development in the U. S., Mr. Moore said that the use of computers to control chemical processing will increase rapidly.

Even now, Mr. Moore pointed out, computers can be instructed to "learn" how to change factors in their control program based on the results of production runs.

No technological unemployment can be expected in the chemical industry because of automation, however. The skilled and scientific personnel will be in demand in other industries using chemicals.

Molecular engineering can be applied to many kinds of chemicals, Earl P. Stevenson, chairman of Arthur D. Little, Inc., reported. He said the synthesis of new drugs may be more important to mankind than any other application of molecular tailoring.

For The Home Lab

Compounds of Zinc

by BURTON L. HAWK

► MY NAME IS ZINC and, like the little red caboose, I always come last. As the author of these articles claims he is tired from overwork, I was requested to take this project on myself. I believe that he has already discussed me as myself (see CHEMISTRY January, 1959), and now the time has come to consider my compounds.

Well, I'm pretty amiable and I combine with many elements quite readily. I suppose you may consider zinc chloride as one of my important compounds. If you do not have a supply, you can make some without too much trouble. Simply drop me in a little dilute hydrochloric acid. As you will see, I dissolve rapidly with a vigorous evolution of hydrogen. After I get rid of the hydrogen, I combine with the chlorine. When as much of me as possible has dissolved, filter and evaporate the solution. Crystals of zinc chloride remain. Be sure the solution is slightly acid, as this excess acid prevents the formation of the basic chloride or the oxychloride due to hydrolysis.

Substitute for Lead

I like sulfur very much and am often found in nature in combination with this element as *sphalerite*, ZnS . To prepare zinc sulfide in the laboratory, simply add a little ammonium sulfide to a solution of zinc chloride. Note that the sulfide is *white*. Now, this is quite important and it makes me more desirable than lead for use in paints. You see when sulfide fumes attack lead base paint, the black lead

sulfide is formed and, of course, the paint darkens. But when sulfide fumes attack paints made with me, the sulfide formed is white and my paints do not darken.

If you add a small quantity of sodium hydroxide solution to zinc chloride solution you will obtain a white flocculent precipitate of zinc hydroxide. But if you add more sodium hydroxide, the precipitate will dissolve and you now have a solution of sodium zincate. This happens because my hydroxide happens to be *amphoteric*. That means that the compound will dissolve in either acids or alkalis to produce the zinc salt of the acid or the zincate of the alkali. If you want to obtain the sodium zincate (although I don't know why you would want it), simply evaporate the solution to dryness. And what is sodium zincate used for? I'll be darned if I know.

Component of Paint

I am a component of the important paint pigment known as *lithopone*. The pigment is intensely white and it forms a non-poisonous paint which has good covering power and does not darken in the presence of sulfides. But, do you know what? It does darken in strong sunlight. Why? (Ha ha). This embarrassing trait has not been fully explained and, indeed, I don't believe it is fully understood. Oh, I suppose some day some nose-chemist will find out, but right now it is my secret. Lithopone consists of an intimate mixture of barium sulfate

and zinc sulfide. It is made by the interaction of the salts, zinc sulfate and barium sulfide. Prepare a solution of zinc sulfate by dissolving a few crystals of the compound in water. In another container, dissolve a small portion of barium sulfide in water. Barium sulfide is only slightly soluble, so you will have to heat the solution and coax it along to dissolve as much as possible. Add the zinc sulfate solution to the barium sulfide in small quantities and heat again. The very white precipitate of lithopone separates out.

More Tests

Zinc sulfate can be prepared by dissolving me in dilute sulfuric acid, the same way as zinc chloride was prepared from hydrochloric acid above.

My other compounds are mostly uninteresting white powders, so I guess there's no point in preparing more of them. The stearate is quite popular as it is used as an antiseptic dusting powder for babies. The acetate is used as a mordant in dyeing, which means, I guess, that it helps things dye. The bromide is used in photography and the carbonate in porcelains and pottery. The oxide, made by heating me in the air, or found in nature as the mineral *zincite*, ZnO , is used in considerable quantity in the rubber industry.

It has been requested by the tired author of these articles that I include some simple tests for those who wish to confirm or detect my presence. I

don't know why . . . it seems silly to me.

Well, anyway, if you add a solution of sodium hydroxide to the suspected zinc solution, you will obtain the white zinc hydroxide which dissolves easily in excess alkali. But, as some other metals behave similarly, you must confirm this test with another one. Add a solution of potassium ferricyanide to the zinc solution. A yellow-brown precipitate forms . . . one of my few colored compounds. Another one is cobalt zincate which is green in color. It is also called Rinnmann's green, and it makes a good test for me. Place the compound of zinc in a small cavity made in a charcoal block. Moisten the solid with a solution of cobalt nitrate and heat the mess . . . I mean mass, with a blow-pipe flame. Use the reducing or inner portion of the flame. A green residue is obtained which indicates my presence in the compound.

Now I know why these tests were requested. Perhaps it was thought that I might masquerade as another metal. And sometimes I have been tempted to do so . . . especially as aluminum. Because aluminum always comes first; but I, alas, like the little red caboose, always come last.

Editor's Note — Our Home Laboratory editor writes in a rather light vein and we hope that this kind of galvanizing does not wear too thin. His old friends among our readers may welcome this change of pace. — W. D.



Answers to CHEMISTRY QUIZ on page 19.



A: 1 c, 2 e, 3 d, 4 c, 5 b; B: 1; C: 1 b, 2 e, 3 h, 4 g, 5 f, 6 d, 7 c; D: 1.

Speedier Process for A-Fuel

► A SPEEDIER PROCESS of producing fuel elements for atomic power stations by using a concentrate of uranium as the starting material instead of the crude ore is now coming into operation at Britain's nuclear fuel factory at Springfields. It will serve the needs of the giant British nuclear power program, as well as supplying fuel for overseas reactors.

The factory is also making special fuel elements for the British Industrial Collaborative Experimental Pile at Harwell, built to carry out research into reactor design for the five industrial consortia in the U. K. engaged on A-power work.

The use of the concentrate, which is a crude uranium oxide, eliminates the peroxide precipitation stage of the earlier process which began with pitchblende.

Processing Method

The concentrate is delivered in drums to the ore storage area and these are taken up by lift to the tipping area as required. The lids are removed and the drums passed into the totally enclosed tipping cubicle where the concentrate is tipped into a hopper with a screw feed to the dissolvers. In large stainless steel tanks fitted with steam heating coils and stirrers the concentrate is dissolved in nitric acid and the solution, after cooling, is fed to rotary filters.

The uranium solution is then purified by solvent extraction with a solution of tributyl phosphate (TBP) in odorless kerosene in mixer-settler units arranged in a cascade.

At the top of the plant the tributyl phosphate emerges containing the uranyl nitrate in solution, passes through a heating unit and the uranyl nitrate is then washed out of the solvent by a weak nitric acid solution. It is then treated with ammonia to precipitate the uranium as ammonium diuranate. This compound is put through the Dryway plant to emerge as uranium tetrafluoride.

The uranium tetrafluoride, and magnesium turnings, are delivered to an automatic weighing and mixing machine which feeds the pelleting press. The pellets of UF₄-magnesium are built up inside the lining and the whole assembled into the reactor. The reactor is passed into the adjacent furnace bay where it is placed in an electric furnace in which the reduction reaction takes place. After cooling the reactor is brought back, dismantled and the slag and uranium billet removed.

The billet goes to the cleaning section where it is cleaned, sampled and numbered, and sent to store.

Billet to Fuel Element

The first step in the conversion of the uranium metal into a fuel element is to melt the billet in a vacuum furnace heated by a high frequency induction current and pour the molten metal into cylindrical molds. The method used is to pour a complete melt at once by removing a spigot in the base of the furnace. The metal runs into a header which feeds several molds, the number depending on the length of bar being cast.

After cooling, the mold assembly is dismantled and the rods taken into the bond store, each cast being kept separate.

The rods then undergo a succession of machining operations to bring them to the desired design, with heat treatments included to produce a satisfactory metallurgical condition to minimize distortion during irradiation.

The machining operations are entirely conventional and are carried out on standard lathes or centerless turners, the only special precautions taken being the provision of an exhaust system away from the operator and a copious supply of coolant to prevent ignition of the swarf and minimize the risk of particles escaping into the atmosphere.

The turnings are collected, cleaned

and added to subsequent casting charges.

Finally the rods — inspected, checked for dimensional currency and individually numbered — are sent for assembly into fuel elements.

Aluminum Discarded

Early fuel elements, for BEPO and the Windscale reactors, used aluminum as the canning material, but the higher operating temperature in the Calder Hall reactors meant that aluminum would lose so much of its strength that it was no longer suitable. The change from air to relatively inert carbon dioxide as the cooling gas eliminated the fire risk associated with magnesium, and the cans for Calder Hall, Chapel Cross and the reactors of the civil nuclear power stations now under construction are of a magnesium alloy known as Magnox.

Process Produces Distortion-Free Glass

► A NEW glass-making process may soon mean better and cheaper glass for automobiles, buildings, display windows and mirrors.

It combines the best properties of plate glass and fire-finished sheet glass, the British Information Services has reported, to give a distortion-free product without the costly grinding and polishing necessary in previous methods.

Developed by Pilkington Brothers Ltd., St. Helens, Lancashire, England, the process consists of passing a continuous ribbon of glass from the furnace to float on the surface of a molten metal at controlled temperature. The ribbon emerges with a brilliant lustrous finish on both sides.

The product will be intended initially for automobiles, but later is to be supplied for mirrors and building uses.

The process took seven years of research and \$11,200,000 to develop.

It is said to have three main technical advantages over earlier methods:

1. It makes glass that is exceptionally parallel and free from distortion.
2. It makes glass with fire-polished surfaces of better quality than that achieved by grinding and polishing.
3. It is completely continuous and thus lends itself to a fully mechanized cycle from handling the raw materials to packing the glass for delivery.

Atomic "Ghost" Discovered

► AN ATOMIC "ghost" that can be detected only by markings left by other nuclear particles has been discovered by a group of scientists in the University of California's Lawrence Radiation Laboratory.

The newly discovered particle is the xi zero, or neutral cascade hyperon, one of the "strange" fleeting fragments of matter found only in cosmic rays and in beams produced by the most powerful atom smashers, in this case the giant bevatron at Berkeley.

Discovery of the particle completes the list of presently predicted particles of ordinary matter. A few predicted antiparticles remain unobserved.

The xi zero has a mass some 40% greater than the proton, or about 1,326 Mev. It has no electrical charge, so it was invisible in the 15-inch hydrogen bubble chamber in which it was found. It has a lifetime of about one ten-billionth of a second.

The particle was discovered by means of the Laboratory's 15-inch liquid hydrogen bubble chamber. The chamber was exposed to a special beam of particles produced by the atom-smashing bevatron. The Berkeley scientists found only one photograph out of a series of 70,000 taken during experiments with evidence of the creation of the xi zero.

The discovery was a difficult feat. The scientists had to filter the bevatron beam to obtain a nearly pure beam of negative K particles.

In the discovery photograph, the scientists saw the track of a negative

K particle enter, then stop. At some distance were two V-shaped tracks, made by other charged particles. In between was a gap, through which neutral particles, created by the interaction of the negative K with a proton, traveled to the points at which they decayed into the V's.

The double V is common in bubble chamber pictures taken at the bevatron. But one V was so askew that it could not have been made by a particle traveling direct from the negative K-proton decay. The scientists deduced that one particle generated by the negative K-proton decay was the xi zero, that it traveled off at an angle, decayed into a neutral lambda hyperon, which in turn decayed into the visible V.

The discovery is outstanding in that it was dependent upon observation of two interconnected invisible "tracks" between sets of visible tracks in the photograph. Analysis of single invisible "tracks" has been common.

The particle had been predicted by Dr. K. Nishijima, a Japanese physicist, and Dr. Murray Gell-Mann of California Institute of Technology.

The researchers who performed the work, reported in current *Physical Review Letters* (March 1), are Drs. Luis W. Alvarez, Myron L. Good, William Graziano and Stanley G. Wojcicki, of the University of California, Berkeley; Philippe Eberhard, visiting physicist from the Centre Nationale de la Recherche Scientifique de France, and Harold K. Ticho of the University of California, Los Angeles.

Lithium Experimental Kit

► THE LIGHTEST of all solid elements—lithium—is the subject of a unique experimental kit that contains samples of lithium ore and two common lithium compounds.

The kit is the current monthly experimental unit of THINGS of science, issued by Science Service.

The lithium unit explains sources, preparation, properties, uses and conversion methods of this solid element that is so light it will float even on gasoline.

Included in the kit are specimens of spodumene ore, lithium chloride and lithium carbonate. Eleven experiments are provided to help the home experimenter understand properties and importance of lithium.

Unrecognized for almost a century after the element was discovered in 1817, lithium's great potentialities did not become apparent until comparatively recently. (See February, 1958 CHEMISTRY for exciting discovery story.)

Today, lithium and lithium compounds play important roles in varied

fields, including lubricating greases, air conditioning and refrigeration, welding and brazing, metal refining and other branches of metallurgy. Its unique properties have made it a valuable synergist in the metallurgical field.

Another recent unit of THINGS of science contained parts necessary to construct a small electric motor that can be powered by a one-and-a-half-volt dry cell battery.

Complete instructions for its assembly, together with step-by-step illustrations, are provided in this kit.

A limited number of both units have been produced for those not regular receivers of THINGS of science kits each month. These units are available for 75 cents each or three for \$1.50 postpaid by writing to THINGS of science, Science Service, 1719 N St., N.W., Washington 6, D. C. Ask for the Lithium unit (No. 219) or the Motor unit (No. 218). Memberships in THINGS of science are available at \$5.00 for 12 consecutive monthly units.

Isotopic Dating for Rubber

► AN ISOTOPE dating technique which will be of value not only to the rubber industry, but an extensive variety of American industries and the public in general is being developed by the Goodyear Tire & Rubber Company, under contract to the Office of Isotopes Development of the Atomic Energy Commission.

In connection with the length of

storage and service of many military supplies, an isotopic dating method has wide potential. As an example, airplane tires have limited storage and service lives so that a method for readily determining their ages would be of great value.

Another broad area of application is determination of the average age of all kinds of returnable containers.

This information is essential for development of improvements in durability of the containers.

In the general area of protective or preventive maintenance where replacement could be made before failure, the average age of articles in actual service could be determined easily. An isotopic dating method could be used where code numbers and other markings had been worn away through service.

Isotopic dating in this connection would be of special value for electronic tubes and circuit components, electrical insulation and delicate mechanical parts of complex computer systems.

In the field of agriculture, such a dating technique would be useful in the dating of seeds for which germination qualities depend upon storage time.

Even with products such as paint, roofing and flooring, it may be possible for manufacturers to use isotopic

dating to check on the age of products that have failed or been returned.

By measuring the amount of radiation from known radioactive materials, it is possible to compute the age of an item in which the materials are present. Amount of radioactive isotopes required for any product to be dated by such a method would be comparable to the amount of normal background radiation. Recent development of ultra-sensitive low level counting devices makes it possible to monitor extremely low amounts of radiation.

Goodyear's research work will be applied to representative pairs of selected isotopes so that one isotope serves as a standard against which to measure the other and thus determine age.

On the basis of this work, a further selection will be made of the best pairs of isotopes to cover a range of age determinations of from several weeks to 50 or 100 years for various products.

Jet Mining in Coal Industry

► HYDRAULIC JET mining has a definite application in the coal industry, and coal pipelines may become more popular as rail rates increase.

This was reported to the Society of Mining Engineers of the American Institute of Mining, Metallurgical and Petroleum Engineers, by John H. Baker of American Gilsonite Co., Salt Lake City.

But hydraulic mining is not a cure-all, he said, and there are probably many instances where it would not work at all.

Jet cutting methods in the United

States, said Mr. Baker, are based on using small quantities of high pressure water to fracture and dislodge the ore, and then low pressure water to fume or convey the ore. The jet nozzle is kept as close to the face as possible because there is a definite loss in efficiency as the distance between the working face and the nozzle increases.

Fracturing, bedding planes and cleavage faces are much more important than hardness of the material in the proper breaking of the ore, he said.

More Nuclear Tests Required

► DEVELOPING peaceful uses for nuclear explosions, such as mining shale for oil in the Colorado Plateau, will require further nuclear tests, even if the U. S. and Russia agree on a weapons test ban in their current talks in Geneva.

Atomic Energy Commission chairman John A. McCone told a news conference such further tests might be supervised by an international commission set up under the hoped-for agreement. He said peaceful uses would be discussed during the Geneva talks, and expressed hope that the status of non-weapons tests would be spelled out soon.

Mr. McCone confirmed that the Nevada and Pacific test sites were being maintained in a state of readiness that would permit their use within a short time. Peaceful uses of nuclear explosions, he said, were a separate issue from weapons tests.

The Government's official position is to support a permanent suspension of weapons tests, provided there are

adequate safeguards to allow detection and identification of outlawed explosions with the highest attainable degree of certainty.

One problem is the difficulty of distinguishing between nuclear tests and earthquakes. The 1958 series of three shots showed the 1957 single explosion was unusual, Dr. Willard F. Libby, AEC commissioner, said. The recent tests proved that the detection system proposed on the basis of the one unusual explosion was inadequate.

Mr. McCone said the lowest limit of detectability may be as high as 20 kilotons, equivalent to 20,000 tons of TNT.

Peaceful applications of nuclear explosions being investigated by the AEC include excavation, such as harbors; power production; isotope production; recovery of oil from oil shales, tar sands and depleted wells; mining, and scientific studies in seismology, geology and special chemical reactions.

Camera Works from Sound

► A TELEVISION camera that gets its picture by using ultrasonic sound, not light, and that can show clearly the internal structure of engineering components and materials and parts of the human body has been demonstrated to the Institution of Electrical Engineers.

The new instrument, which may become of considerable use to engineering, and to medicine, was demonstrated by its inventors, Dr. C. N. Smyth of the obstetrics and gynecolo-

gy department at London University College Hospital Medical School, and J. F. Sayers.

This ultra-sound "television" camera differs from an ordinary television camera in that the light-sensitive (photoelectric) image-receiving surface is replaced by a sound-sensitive (piezo-electric) image-receiving surface.

This is simply a bare slice of crystalline quartz which under the impact of sound develops on each point

of its surface a voltage proportional to the ultra-sound intensity. The value of this voltage is detected, point by point, by a scanning electron beam, and after amplification controls the brightness of a television receiver to produce a visible image of the invisible internal structure under examination.

The demonstrations of the new camera included the examination of objects immersed in a tank of water. Internal flaws in blocks of aluminum revealed their shape and size clearly. Electroplating poorly adhering to the base metal showed as dark patches.

The internal parts of a goldfish and of some medical specimens were clearly seen, and when the hand of the demonstrator was immersed in the

tank, the structure of the fingertips and the palm of the hand were shown.

It was stated that sound intensities used (milliwatts per square centimeter) are too small to have any adverse biological effects, a factor of prime importance particularly in the examination of regions of the body sensitive to the effects of X-rays.

Ultrasonic sound waves are in many ways similar to light waves or rays. They can be focused with lenses, and images of objects exposed to noise can be formed and reproduced at a distance.

This instrument has been developed through the generosity of the R. W. Paul Instrument Fund at the Northampton College of Advanced Technology, London.

Space Helmet to Study Fatty Acids

► HERE'S A NEW USE for a space helmet — to enable doctors to learn more about the body's fuel system.

Drs. Josiah Brown and Leslie R. Bennett of the University of California at Los Angeles Medical School have used such a device in investigating the way the body utilizes fatty acids.

Fatty acids have been recognized only recently as perhaps the major body fuel in the fasting state, the investigators point out. Little is known about how the body burns this energy source.

Fatty acids tagged with radioactive carbon are injected into human subjects. A "space helmet" is placed over the subject's head so that his exhaled breath is captured and carried to a special machine which is so sensitive that it can measure the amount of radioactive carbon exhaled.

These measurements give an indication of the rate at which the radioactivity tagged fuel is being burned.

Several malnutrition patients have been studied in this manner. Results indicate that in these patients, in which fuel sources from food (principally carbohydrates and sugar) are not utilized properly, the body adjusts its carburetor to burn the rich mixture of stored fatty acids. Such patients live primarily off their body fats.

Even in normal people the body readjusts its carburetor to burn the rich fatty fuels stored in the body about two to three hours after eating. This is approximately the length of time it takes to use up the predominantly carbohydrate-sugar fuel mixture we obtain from food.

New Diamond Uses Needed

► DIAMONDS are a girl's best friend. But are they just as highly regarded by industry?

Not if industry's restricted use of them is any indication, says J. D. Kennedy, diamond section manager of General Electric Company's metallurgical products development section.

Mr. Kennedy told the American Institute of Mining, Metallurgical and Petroleum Engineers that there is a far greater field of uses for diamonds than industry realizes — especially with the increasing abundance of good-quality man-made industrial diamonds.

Diamond is about five times harder than the next hardest abrasive, he said, and there is no reason why its use should be restricted to a handful of applications.

Mr. Kennedy is convinced the only reason industry has avoided more widespread use of diamonds can be traced to a history of limited availa-

bility. Until recently, he said, industry never has had long range assurance that it could expect any planned expansion of the basic supply of diamonds. Therefore, it never has been given any real encouragement to develop new diamond applications.

Although the hardness of man-made diamonds has been found to be "comparable to its natural counterpart" in many instances, Mr. Kennedy believes the major development problem now lies in developing somewhat larger, stronger crystals.

If we are to achieve the ultimate goal of providing American industry with an independent, domestic, unlimited supply of all industrial diamonds, he said, we must increase the size of diamonds, modify their quality to suit specific needs, and further reduce their cost.

Mr. Kennedy said he was "quite optimistic" about our ability to achieve this ultimate goal.

Amplifying Light Beams

► A NEW ATOMIC method for amplifying light beams has been developed by using excited gas molecules in a maser-type device.

This would mean, in effect, that the light from a flashlight could be made very much stronger with the same amount of power through use of such an optical maser. Successful development of the device, now undergoing laboratory tests, would result in important applications in projecting television pictures, in photographing astronomical objects, and in

medical diagnosis by X-rays or fluoroscopy.

Dr. C. H. Townes of Columbia University reported his work on optical masers with Dr. A. L. Schawlow of Bell Telephone Laboratories to the American Physical Society meeting.

Solid-state masers of ruby and gaseous masers already developed operate in the microwave region of the radio frequencies. The term "maser" stands for "microwave amplification by stimulated emission of radiation." In am-

plifying a weak signal, masers have the great advantage of adding very little background "noise," equivalent for radio waves to the "snow" seen on television sets.

Masers are therefore coming into use to extend considerably the range of such sensitive detecting equipment as radar or radio telescopes, and in radio communications.

Drs. Townes and Schawlow are now investigating the possibility of an optical or infrared maser, which would amplify light or infrared waves. Prospects are favorable.

An infrared maser would have application in detecting objects by the heat waves they emit.

One system being investigated for an infrared maser uses atomic potassium vaporized to its gaseous state. The spontaneous emission should be

a few thousandths of a watt of power in a system two and a half inches in width and four inches long. Drs. Townes and Schawlow have calculated.

Instead of using a cavity for the gas molecules as in present-day masers, Dr. Townes said two parallel reflecting plates could be used.

Dr. Townes also reported that a solid-state maser attached to the Naval Research Laboratory's 50-foot radio telescope antenna is being used successfully. With it, radiation from Jupiter had been detected that showed some variation in the planet's temperature apparently associated with large-scale atmospheric disturbances. The planet Venus has been shown not to cool off much during its night, and some new astronomical sources of radiation at 9,000 megacycles have been found.

Dispute Fallout is Harmless

➤ ONE OF THE central figures in the scientific radioactive fallout controversy issued a vigorous rebuttal to a recent report that present contamination with strontium-90 is "extremely unlikely to induce even one bone tumor or one case of leukemia."

Dr. Linus Pauling of the California Institute of Technology, Nobel Prize winner in Chemistry, declared the conclusion of the report is "completely unjustified."

The disputed account, based on mouse studies by Dr. Miriam P. Finkel of the Argonne National Laboratory, appeared last Sept. 19 in *Science*.

Dr. Finkel concluded that there is a threshold value for the ingestion of strontium-90 below which man does

not suffer any ill effects. Since the present level of fallout is far below the threshold value, she indicated there is no cause for alarm.

Dr. Pauling, with an Institute colleague Dr. Barclay Kamb, made his views known in a current issue of *Proceedings of the National Academy of Sciences*.

"We have made an analysis of Dr. Finkel's data that shows she had no justification whatever for her concluding statement," they said.

"All of her data are compatible with a zero threshold for strontium-90."

"Moreover," Drs. Pauling and Kamb said, "... in order for Dr. Finkel to have been justified with

90% confidence . . . she would have to have used over 1,000,000,000 mice in each of her groups, instead of the 150 or less that were used."

They claim that a fallacy in Dr. Finkel's statistical argument is that

she failed to control for a type of error. The error, they said, is her acceptance of a hypothesis that there is no difference in response between control mice and mice dosed with strontium-90.

Ultrasonic Sound Cleans Fossils

► ULTRASONIC sound waves which cannot be heard are used to clean 200,000,000 years of dirt off marine sediments too small to be seen.

Dr. Gary Lane, assistant professor of geology at the University of California at Los Angeles, treats the tiny fossils as gently as a mother bathing her baby, but there the similarity ends.

Before the ultrasonic bath, he breaks up the shales containing the microscopic fossils, soaks them in kerosene, boils them in water, and then immerses them in a one-gallon tank.

The tank is part of the Narda Son-Blaster, a useful and simple ultrasonic cleaner, consisting of a transformer and transducer.

The transducer sets up the sound waves, vibrating at the rate of 30,000 to 40,000 times a second, which shake

the deeply imbedded sediments off the fossils.

Dr. Lane's fossils, collected from roadcuts around Manhattan, Kans., once floated in the oceans of the Middle West, when that part of the country was covered by water during the Permian age.

As the waters receded, the empty ocean basin filled up with gradually hardening sediments, which entrapped and thus preserved the marine fossils.

By studying and classifying the cleaned fossils, the UCLA paleontologist hopes to chart the distance offshore and the depth of water that covered northeastern Kansas some 200,000,000 years ago, as accurately as if some prehistoric cartographer had drawn an oceanographic map of the area.

Lithium Held Due to H-Bomb Explosion

► THE LITHIUM ATOMS found high in the atmosphere during 1957 and 1958 resulted from exploding hydrogen bombs.

Dr. D. R. Barber of the University of Exeter's Norman Lockyer Observatory, Sidmouth, England, said it was "highly probably" that the mysterious lithium airglow observed in south polar regions was man-made and totally unrelated to passage of meteoritic

dust through the earth's upper atmosphere, as some scientists suggested.

If the mushroom-like cloud of the hydrogen bomb exploded in August, 1958, released lithium atoms at a height of about 96 miles, then the lithium airglow would last about 90 days after the detonation, Dr. Barber calculated. A study of observations has partly verified this calculation, reported in *Nature* (Feb. 7).

Book Condensations

GENERAL CHEMISTRY — William K. Nebergall and Frederic C. Schmidt—*Heath*, 723 p., illus., \$7.50. A first-year course in college chemistry.

THE ESSENTIALS OF CHEMISTRY — R. P. Graham and L. H. Cragg — *Rinehart*, 579 p., illus., \$6.50. A well planned high school textbook.

CHYMIA: Annual Studies in the History of Chemistry, Vol. 5—Henry M. Leicester, Ed.—*Univ. of Pa. Press*, 214 p., illus., \$5. Original research articles on early and recent phases of the history of chemistry.

A CASTABLE POLYURETHANE — A. J. Quant — *Sandia Corp. (Office of Technical Services)*, 13 p., paper, 50c. Discusses elastomer with outstanding thermal-shock resistance.

THE STRUCTURE AND PROPERTIES OF POROUS MATERIALS — D. H. Everett and F. S. Stone, Eds. — *Academic*, 389 p., illus., \$12. Proceedings of the Tenth Symposium of the Colston Research Society held at the University of Bristol in 1958.

NOMOGRAMS FOR CHEMICAL ENGINEERS — Om P. Kharbanda, foreword by Sir Harold Hartley — *Academic*, 247 p., \$15. One hundred nomograms covering the main physical constants likely to be needed in chemical engineering calculations.

SOLID PROPELLANT ROCKETS — SECOND STAGE: An Introductory Handbook — Alfred J. Zachringer — *Am. Rocket Co.*, 306 p., illus., \$8. For the engineer or scientist.

THE FILM VAPORIZATION COMBUSTOR FOR GAS TURBINE ENGINES: Theoretical and Experimental Investigations — Gunter W. Maybach — *Pa.*

State Univ., College of Engineering, 142 p., illus., paper, \$2.

LIQUID HELIUM — K. R. Atkins — *Cambridge Univ. Press*, 312 p., illus., \$11. Exposition of the current state of the theory and detailed survey of experimental results.

ANALYTICAL CHEMISTRY: Some New Techniques — A. G. Jones — *Academic*, 268 p., illus., \$7.50. Includes flame photometry, differential spectrophotometry, gas chromatography and differential refractometry.

SOME PROBLEMS IN CHEMICAL KINETICS AND REACTIVITY, Vol. I — H. N. Semenov, transl. from Russian by Michel Roudart — *Princeton Univ. Press*, rev. ed., 239 p., paper, \$4.50. This book on the chemical kinetics of chain reactions first appeared in 1954 in Moscow.

POISONS: Properties, Chemical Identification, Symptoms and Emergency Treatment — Vincent J. Brookes and Morris B. Jacobs — *Van Nostrand*, 2nd ed., 272 p., illus., \$6.50. A handbook for quick reference.

QUANTITATIVE CHEMICAL ANALYSIS — Gilbert H. Ayres — *Harper*, 726 p., illus., \$7.50. College textbook covering the fundamental principles of elementary quantitative analysis, both theory and practice.

GAS TUBES — Alexander Schure, Ed. — *Rider*, 72 p., illus., \$1.50. Includes chapter on thyatron.

THE METAL THORIUM: Proceedings on 1956 Conference on Thorium — Harley A. Wilhelm, Ed. — *Am. Soc. of Metals*, 397 p., illus., \$10. Conference was held in cooperation with the Atomic Energy Commission.

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